THE

ELECTRICAL REVIEW.

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THE

UNIVERSAL ELECTRICAL DIRECTORY

1901 Edition

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DEPRECIATION.

IN referring in our "Correspondence" columns last week to our article of the 1st inst., Mr. David Urquhart appears to advocate as a principle of sound accountancy the division of the initial cost of plant and its renewal at the end of its "life," between the ratepayers of to-day and those of 30 years hence.

Why, he appears to argue, should the pioneer ratepayers bear all the cost and not leave some burthen to be borne by those who enjoy hereafter the benefit of their enterprise? Such views are often heard in support of a system of adding the cost of war to the National Debt. We spend 100 millions over the war in South Africa, which is to secure advantages for future generations. Why should they not pay in what Mr. Urquhart calls "strict justice," their share of the costs incurred by their predecessors?

We are afraid that such a principle cannot be applied to ordinary business transactions, and that traders must pay their way as they go. Municipalities depart from sound doctrines when they embark in undertakings without knowledge or capital; but if they do so, conditions should be imposed which compel the keeping of the accounts on proper commercial principles.

Mr. Urquhart practically says to the ratepayer of 30 years hence, "we have paid the original cost of the plant by the operation of our sinking fund, it is now of no value by 'the automatic action of wear and tear,' and it is for you to do your share by providing capital for its renewal," or to put it plainly, depreciation and renewal is to be provided for by fresh loans, instead of out of the profits of the undertaking.

This, we contend, is bad finance, and entirely opposed to the principle upon which the Board of Trade prescribe the form of accounts, and their auditor deals with the companies.

In another column we publish a letter from Mr. Horace Boot, consulting and resident electrical engineer to the Tunbridge Wells Corporation, who thinks that a local authority is perfectly justified in treating the sinking fund as a redemption fund, and adds, in somewhat involved terms, the remark, "and whether or not it is necessary to add to this amount set aside in order to increase the total amount put towards depreciation, must depend upon circumstances."

What this means, we do not quite understand, but as Mr. Boot goes on to say that in Tunbridge Wells he is satisfied for the sinking fund to "form the depreciation fund," we presume that he does not consider it necessary to provide for the renewal or reduced value of his plant at all.

Mr. Boot quotes the practice of some companies who do not set aside any sum for sinking or redemption fund—as a reason why local authorities should treat the repayment of their borrowed money as a depreciation or renewal fund, a *tu quóque* argument which is, at best, a weak one, for if the wicked company monopolists do wrong, it is no reason why virtuous Tunbridge Wells should not do right.

The Glasgow Corporation have adopted 4 per cent., as we

have already shown, as a fair amount for depreciation, and at the meeting of the Town Council of Tunbridge Wells in June, 1897, Sir David Salomons, a high authority on finance, advocated the formation of a depreciation or reserve fund in connection with the electric lighting works. He thought that they should lay aside a sum equal to 5 per cent. on the capital outlay upon machinery, mains, &c., out of which all renewals in successive years could be paid.

Alderman Cronk considered that the statement of profit was fallacious, while the Town Clerk explained that under their provisional order they had power to create a reserve fund to be invested and accumulated to one-tenth of the capital, but the difficulty was for what purpose they could use the reserve.

Eventually the accounts were passed as presented, and have been so rendered ever since—no provision being made for depreciation and renewal, notwithstanding the good advice of Sir David Salomons and the example of Glasgow.

Mr. Boot admits a depreciation of 2·83 per cent., but he does not say that a fund has been created on that basis for meeting the renewals and reduced value of plant. If such existed it would show for the five years since the works were started (apart altogether from sinking fund for repayment of original cost of plant) the following amount:—

Year.	Capital expenditure.	Depreciation at 2·83 per cent.
1896	£15,408	£439
1897	23,923	684
1898	31,275	891
1899	37,817	1,076
1900	42,843	1,211
		£4,301

So far from any such fund having been created, the accounts only show a provision by sinking fund during the five years of £3,319 towards repayment of the capital borrowed.

Mr. Boot has no justification for supposing that the plant of a local authority is kept in better order than that of a company. This is a reflection upon the electrical engineers in charge of works which should not be made, and from our experience of electricity supply works, they are, as a rule, kept in excellent order, whether belonging to municipalities or private companies.

There is some force in Mr. Corringham's suggestion that the value of land and plant should be readjusted at stated periods; but meanwhile the necessity remains for a fairly constituted depreciation and renewals fund.

ELECTRIC LIGHTING ACTS AND ORDERS.

The interesting case in which the Metropolitan Electric Supply Company, Limited, figured as defendants in the Marylebone Police Court on Saturday last, serves to show that supply companies cannot infringe the Electric Lighting Acts and Orders with impunity. According to the report which we publish elsewhere, it seems that in May last the company was desirous of laying down a number of low-tension mains in Marylebone for the purpose of transmitting energy from a distant station. With a view to obtaining the necessary consent of the local authority, it submitted plans of the proposed works to the Marylebone Vestry, whose jurisdiction is now vested in the Marylebone Borough Council. With one exception all the works described in these plans were agreed to. Subsequently, at the end of November, it was discovered that the works actually undertaken deviated in several material respects from those authorised by the plans; that mains, instead of being laid under the footway, were placed under the carriage-way, and had been laid one on the top of the other instead of side by side. The defendants had also laid extra mains. The company through its counsel pleaded *Guilty*, but it was urged in extenuation that the only serious charge which had been proved against it was the laying of extra mains, which had been authorised by the engineer acting under a mistaken idea of the rights. It was also pointed out that the mains were laid in order to supply without delay a continuous current to two of the company's customers. The magistrate expressed the opinion that the plans were misleading, and that nothing would have been heard of the extra mains but for the discovery which had been made by the Council. The company was fined £56 on the five summonses to which it had pleaded guilty, the remainder being withdrawn.

Without access to the West London Electric Lighting Order of 1889, under which, as we are informed, the above proceedings were instituted, we must suppose that the real reason why the local authority pressed these summonses to a conclusion was that they wished to induce other supply companies to refrain from making any departure, however trivial, from the plans of the works which are deposited with the local authority. However that may be, the way of the private electric lighting company is truly a hard one. While it is bound upon the one hand to protect and study the interests of the consumers, any superfluous zeal which it displays in that direction is liable to be checked by the strict enforcement of rules and regulations by the local authorities. Even at the present time, the objection of one or two consumers to receive a supply of electricity at increased pressure has involved one of our metropolitan companies in an expensive inquiry before the Board of Trade. It is most unreasonable that a laudable endeavour to meet all consumers should be checked by the local authority. A glance at the statutes show that companies labour under far too many restrictions.

Thus it is provided by Sec. 30 of the schedule to the Electric Lighting (Clauses) Act, 1899 (62 and 63 Vict., c. 19), which Act only applies, of course, to districts outside London, that whenever undertakers make default in supplying energy to any owner or occupier of premises to whom they may be and are required to supply energy under the Special Order, they shall be liable in respect of each default to a penalty not exceedingly 40s. for each day in which the default occurs. If the "undertakers" are not the local authority, and they make default in supplying energy to public lamps, they may be liable to a penalty of 40s. a day for each lamp (Sub.-sec. 2). If any further testimony is required to show the serious responsibilities attendant upon the supply of electricity, we need only refer to Sec. 77 of the schedule to the above Act, which reads thus:—"Undertakers shall be answerable for all accidents, damages, and injuries happening through the act or default of the undertakers, or of any person in their employment, by reason of, or in consequence of, any of the undertakers' works, and shall save harmless all authorities, bodies, and persons by whom any street is repairable, and all other authorities, companies and bodies, collectively and individually, and their officers and servants from all damages and costs in respect of those accidents, damages and injuries."

MULTIPLEX WIRELESS TELEGRAPHY WITH TUNED APPARATUS.

Prof. A. Slaby delivered a highly interesting lecture in Berlin on January 22nd in the presence of the Emperor and many high officials. The lecturer was induced to take up the subject of wireless (or as he prefers to call it, "spark" telegraphy), by his desire to devise a system for the German Navy which should be independent of the Marconi patents. In conjunction with Count Arco he invented a new method which was adopted on board a number of German warships, and it is stated to have answered perfectly. Prof. Slaby, however, confesses to a certain disappointment that at that time their investigations did not enable them to obtain, under the most favourable conditions, any better results than those given by the Marconi system. Their efforts especially to tune their apparatus and so prevent communications interfering with each other could only be regarded as a failure; and up to 12 months ago Prof. Slaby was sceptical as to the possibility of successful tuning. But at the beginning of October last he and Count Arco resumed their experiments, and this time met with greater success. Wireless telegraphy is still the most obscure and most difficult chapter of electrotechnics, especially when it is a question of reducing the effects to measurement and calculation; but the method of solving the problem may be illustrated by means of analogous mechanical phenomena.

Hertz found that a spark striking a straight wire set up in it electrical vibrations which were propagated through space in regular waves with the velocity of light, and that these waves produced in other conductors, which they encountered on their way, electrical effects accompanied by sparks. If, for example, we set up vibrations in a stretched wire by means of a spark from a small induction coil, we can draw sparks 4 or 5 cm. long from a second wire placed parallel to and at a distance of 1 m. from the first, though there is not the slightest metallic connection between the two. In the dark both wires appear to be uniformly illuminated. The precise law underlying these effects has been stated with perfect clearness by Hertz; the practical man has merely sought out means of increasing the effect.

The electrical phenomenon in the wires is of an oscillatory character, and the observed electric tension is an alternating tension which pulsates 5 million times a second between its maximum positive and negative values. It may be shown by photography that the amplitude of the oscillation increases from the spark-gap to the free end of the wire. This is analogous to the vibrations of a steel wire clamped at one end. The transmission of electrical disturbances in one wire by wave motion to a second wire may also be represented mechanically. Let a steel wire be bent twice at right angles, as shown in fig. 1, the parts *a* and *b* being each one-sixth of the whole length, and let the angular points be fixed, but not too rigidly. If now one of the free ends be set in vibration the movement will be transmitted through the wire, causing the other free end to vibrate in a perfectly similar way. The length of the wire between the two fixed nodes 1 and 5 represents a complete wave-length, comprising a crest and a depression formed by the vibrating segments 2 and 4. It will be at once seen that the proper conditions for transmission are that *the length of the free vibrating wires must be one-quarter of the wave-length.*

Precisely the same law applies to electrical vibrations. The oscillations produced in a vertical wire, *a*, by passing sparks into it at the lower end set up vibrations, the amplitude of which is greatest at the upper end, and the frequency of which is determined by the length of the wire. These vibrations are propagated through the ether with the velocity of light in the form of waves whose length is exactly four times that of the electrically vibrating wire.

If these waves impinge on a second wire, *b*, they will set up in it electrical vibrations, which will be most powerful when the proper rate of vibration of the wire corresponds to the wave frequency, that is, when it is exactly one fourth of the wave length, and its lower end is a node. Both conditions can always be fulfilled, since we can vary the length, and reduce the potential at the lowest point to zero—that is, make it a node—by putting it to earth. Wireless telegraphy became possible as soon as we possessed a means of observing the alternations of potential in the secondary wire. It would not be practicable to do this by taking sparks from the receiving wire, as the effect diminishes with the distance; a spark length of 4 cm. at a distance of 1 m. would be reduced to ·0004 mm. at 100 km., and the spark would be invisible even through a powerful lens. The most sensitive means of detecting these exceedingly low tensions, is the Branly tube or coherer.*

It is filled with metallic powder which offers, when loosely arranged, an extremely high resistance to the electric current; but if it be exposed to electric radiations, innumerable small sparks, imperceptible to the eye, leap from particle to particle, and form by condensation of metal vapour a bridge which enables the electric current to pass through the tube. A slight shock destroys the bridge, and restores the high resistance. Let a galvanic cell be connected to the two ends of the tube, and a signalling instrument be inserted in the circuit so formed; then on exposing one end of the tube to an electric tension, the circuit will be closed in the manner indicated above, and a visible or audible signal will be given. The method which has hitherto been adopted of insulating the receiving wire and inserting the coherer between its lower end and earth is radically wrong. The coherer, as has been proved by measurement, has so large a capacity, that the lower end of the receiving wire may be

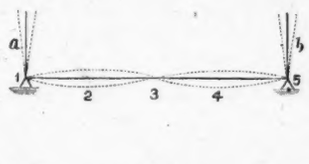


Fig. 1.

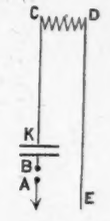


Fig. 2.

regarded as a node for the electrical vibrations set up in the wire, and therefore no appreciable differences of potential can occur there. The coherer is consequently in the least favourable position, and if good results have nevertheless been obtained with this arrangement, they are due to the circumstance that the length of the receiving wire does not generally correspond exactly to one-quarter of the wave length, and that the transmitting apparatus, besides the principal waves, sends out also parasitic waves, which give rise to irregular and insignificant variations of potential at the lower end of the wire. To this is to be attributed the unreliable and capricious behaviour of the receivers hitherto employed. They resemble a defective human ear, which does not perceive the pure fundamental notes of an instrument, but only the accidental noises and overtones which accompany them. By putting the receiving wire direct to earth, thus forming an effective node, and attaching to it at that point a wire of equal length we can obtain at the free end of the added wire an amplitude of electrical vibration equal to that at the top of the vertical wire, with the advantage of accessibility.

The auxiliary wire need not be straight; it may be wound on large bobbins. By these means, in fact, the precision and certainty of the received signals have been increased to a surprising degree. The arrangement enables us to use existing conductors, such as lightning rods, flagstaffs, and iron masts, which are already earthed, as receiving wires for telegraphic purposes. Telegrams were received by Prof. Slaby during the lecture by means of the lightning conductor fixed to the chimney of the central station, to the earthed end of which a wire of definite length leading to the apparatus in the lecture hall was attached. The economical and technical importance of this circumstance is obvious; a wide field is opened up for the utilisation of wireless telegraphy in towns. This more general application could not formerly be seriously contemplated because of the inherent imperfection of the methods of wireless telegraphy hitherto in use. It was not possible to tune the apparatus at two stations so that they could correspond with each other safely

* Called a "Fritter" in German; the superficial fusing together of loose substances being technically termed a "Fritt" process.

and without disturbance from other stations. All electric waves passing through space acted freely on each receiving instrument, secrecy was impossible. When the German warships, provided with the old form of apparatus, were approaching the Harbour of Shanghai they could read when miles off the telegrams which the British warships stationed there were exchanging with each other.

The problem of tuning may now be regarded as solved. According to a statement by Prof. Fleming at the Royal Institution, Marconi has also found a solution, but wishes to keep his methods secret for the present. In Prof. Slaby's system two corresponding stations work with the same wave lengths, which may be varied within wide limits. One method of arranging the receiving apparatus so that it will respond only to a given wave length is to make the length of the receiving wire exactly one-fourth of the wave length or an odd multiple of the same; all the other waves for which the point at which the wire is put to earth does not form a node pass direct to earth: they do not reach the receiving instrument. We, so to speak, sift or filter the waves. By this means freedom from disturbance and secrecy of the correspondence with *one* other station is ensured, but we are not able to correspond simultaneously with several stations, for in respect of wave lengths we are restricted by our lightning conductors or masts: we cannot lengthen or shorten them at will. A fortunate property of the electric waves has, however, rendered the solution of this problem also possible. For waves which are exactly four times as long as the receiving wire the earthed end is a pure node, although slight variations of potential are possible. If the auxiliary wire is of the same length as the receiving wire all waves of other lengths pass to earth at the node. We can, however, cause these waves also to traverse an auxiliary wire if we make the total length of the wire—*i.e.*, receiving wire + auxiliary wire—equal to half the wave length. The earth then no longer forms a pure node for these waves: it allows them to pass almost unimpaired, but allows no others to pass. A numerical example will make this clear. If we wish to receive from a lightning conductor 40 m. high waves whose length is not $4 \times 40 = 160$ m., but perhaps 200 m., we must take 100 m. as the total length of the wire—*i.e.*, we must attach to the lightning conductor of 40 m. a further length of wire of 60 m.

By these simple means we can within pretty wide limits arrange a receiving station for the reception of various wave lengths. We have only to provide a sufficient supply of large coils of wire and set up as many receiving instruments as there are stations with which we desire to correspond. For the sifting of the waves is accomplished with such certainty and exactness that we can even receive various telegrams coming from quite different directions and distances.

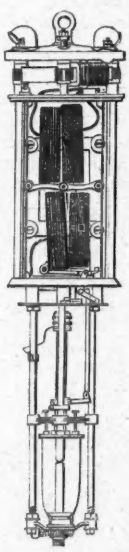
Prof. Slaby claims to have greatly increased the accuracy and strength of the received signals by the use of a simple instrument which he calls a "multiplier," and which consists essentially of a bobbin of wire, the shape and method of winding of which depends on the wave length. It has the property of lowering the velocity of an electric impulse, the result being a considerable increase of the tension. It must not be mistaken for a transformer, as there is no secondary coil. Its action in wireless telegraphy is analogous to that of the sound-board in a musical instrument; it renders the signals stronger and clearer. When such a tuned multiplier coil is inserted between the prolongation of the receiving wire and the coherer, it not only increases the differences of potential at the coherer, but it allows no waves to pass through except those for which it is itself tuned. It was shown by experiment that the distance at which sparks could be taken from a straight electrically vibrating wire was increased from 1 cm. to 10 cm. by the addition of the multiplier. The ends of the multiplier coil emitted radiations which were visible at some distance, and which could be caused to vanish by simply bringing the hand near the coil.

It remains to describe the method of generating electric waves of definite length at the transmitting station. In order to convert a large amount of electrical energy into the oscillatory form, not only is a high potential necessary, but also a large quantity of electricity. To this end Prof. Slaby uses an earthed loop (fig. 2) instead of an insulated wire, and inserts in it a condenser, K (in the form of ordinary Leyden jars) to increase the quantity of electricity. In the process of charging the jars the whole of the loop is used, but in the discharge, which commences on the passage of the spark, and which sets up the rapid electric vibrations which alone are effective in working to a distance, only the vertical wire K C is used. These vibrations are prevented from passing into the earthed wire, D E, by means of a much "out-of-tune" (verstimmt) coil, C D, having great electrical inertia. Such a coil acts as a barrier from which the rapid electric vibrations rebound. The distant effects will be produced solely by the first vertical wire, and will be unaffected by any reaction of the second vertical wire, D E. The waves produced by such a transmitter are of perfectly definite length, which is determined by the length of the wire and the size of the condenser. The wave-length may, however, be varied to any extent by the insertion of tuned coils, whose inertia lowers the frequency of the vibration. To every frequency there corresponds an easily calculated wave-length.

(To be continued.)

ALTERNATING ENCLOSED ARCS IN SERIES.

SERIES systems of alternating arc lighting are in great vogue in the States, but such systems have generally consisted of lamps working with shunt coils, the circuit being run from a constant current transformer. This necessitates the use of a cut-out for each lamp, which is a weak point in the system. Another method which has been employed, but is not now used in America, is to have a choking coil in parallel with the lamp, which, in the event of the lamp failing, substitutes an equivalent of self-induction. The arc circuit for such a system to obtain good regulation must be extremely non-inductive, which means that the controlling power for the carbons can only be weak. Should the lamp



circuit be too inductive, in the event of failure of one of the arcs, the circuit becomes affected, unless a very large current is allowed normally to pass through the choker. The principal reason which necessitates the employment of large controlling power in arc lamps is the existence of a dash-pot. The dash-pot is a piece of mechanism which, when new and clean, is not likely to go wrong, but which, after use, is apt to introduce friction. In order to overcome this, arc lamp designers always use as powerful controllers as possible consistent with not increasing the price of the lamp too much; but in the case of lamps run in series, with chokers in parallel, powerful controllers must not be used on account of increasing the self-induction of the arc circuit.

Mr. Frank Lewis, of the Reason Manufacturing Company, whose system has lately been employed at the Croydon electricity works, employs in his lamp a solenoid, to the core of which is attached a strip which links on to a clutch acting directly on the carbon. The other end of the core is pivoted to a lever, to the axle of which a circular disc is attached. On this disc a brake lever and brake block bear, when a second solenoid is energised.

The action of the lamp is as follows :—When the carbons are together, an abnormal current flows through the striking coil and through the coil which is employed as a brake ; the clutch is therefore pulled upwards, but at the same time the second coil is pulled up, which places the brake on the brake disc, prevents rapid movement of the striking core and prevents the carbons from being separated rapidly. When, however, the current is normal the brake is not in operation, the regulating core being free to move. This mechanism possesses the advantage that if the post is subjected to great vibration, as in the case of lamps suspended on trolley poles, and the carbons tend to hunt, the braking apparatus comes into operation rapidly, while with a dash pot the small movements are not greatly steadied. One of the advantages of series alternating enclosed lamps over parallel lamps is that the large number of lamps in series have a steadying effect, and prevent large abnormal current rushes, while with parallel lamps these often occur. The result is, that in the former case the end of the carbon becomes of a hard gritty nature, which gives the light a much better colour than when the carbon tip is softer ; it also increases the candle-power for a given consumption of power.

We understand that in the Lewis lamp great care has been taken to obtain perfect enclosure for the carbons. Asbestos is nowhere used for obtaining air tightness, as carbon monoxide is able to pass freely through asbestos ; after the lamp has been running for a short time, the gas inside is carbon monoxide and nitrogen.

WIRING RULES AND "SUPPLY RULES."

The law of England is expressed by some complex combination of statutes, common law and precedent, and in dealing out justice able lawyers on either side argue deeply and at length to show the judge how correct and proper the position of each of the contending parties is, whereupon very often an entirely unlooked-for decision is given. Next, perhaps, the case is carried a step further and higher, and the result is to show conclusively that things are just about as wrong as they could be. Finally, the House of Lords tackles the puzzle, and, as it must confirm one or other of the two previous conflicting decisions, it only remains for the winner in the long run to think himself lucky in having taken two out of the three available chances of having his own way. What the "law" really is, depends upon the point of view of whoever may be interested in discussing a question.

Now, if this be the case with matters which have occupied the highest type of intellect and the keenest forensic ability since the earliest days of civilisation, it is not surprising that in a question like the interpretation of regulations and the drafting of wiring rules great divergencies exist, and that very often the same pamphlet contains two clauses mutually destructive and contradictory. One of the most interesting and practical contributions to this really important question has just been given by Mr. F. Broadbent in a paper read before the Newcastle Section of the Institution of Electrical Engineers. The paper is most amusing, and forms a light and refreshing change from the rather heavy mental diet afforded by most of the I.E.E. papers. We strongly advise all station engineers, fire office surveyors and contractors to procure a copy and peruse it in the time they can set aside for the study of light literature. They will derive more satisfaction, and extract more humour from its pages, than could be obtained in the same time from most of the popular weekly journals.

Mr. Broadbent contrasts the requirements of different supply systems with one another, and shows how peculiar some of these are when looked at in the light of everyday practice. For example, many rules limit the starting current of motors, yet few of them say anything about sudden stopping, and in the case of a 50-H.P. motor driving a newspaper printing machine, provision has to be made to stop the machine instantly. Chelsea stipulates that a 3-H.P. motor on starting may exceed its full load current by 25 per cent., say 16½ amperes, but one of larger size must not have more than 10 amperes starting current. In Manchester no motor may take more than 10 amperes at starting, nor increase in steps exceeding this current, but a 15-ampere arc lamp is permitted to strike with 27 amperes. Thus a motor, however large, must not take a starting current of more than one-third of the permissible striking current of a 15-ampere arc lamp! while a 10-ampere lamp may have a larger striking current than a 20-ampere one. The summary of requirements insisted upon by some of the leading supply undertakings attached to Mr. Broadbent's paper is very valuable, and goes far to prove his contention that a great need exists for wholesale scrapping of rules and regulations if any real desire exists for standardisation and uniformity.

Too little attention is paid to the logical basis upon which rests the desirability or necessity for wiring and supply rules. Quoting the paper, we agree that there should be a uniformity of general principles, or what may be called "method," but on the other hand, anything in the way of standardisation that stifles invention, progress or research should be avoided. It is at least particularly true to say that the people who complain most bitterly of the stringency of the Board of Trade regulations are now the worst offenders, but while many of them loudly proclaim the need of uniformity, they contribute to the want of it by issuing rules which are uniform with nothing under the sun.

The scope of rules seems to be fairly clear. Questions of fire risk are surely best left to the insurance offices, who will in time learn to leave well alone, except in those matters that actually affect them. As Mr. Raworth has pertinently remarked, where is there anything in electrical work comparable in risk with a water-slide gasolier, or we would add, with the naked gas flames which decorate and display the goods in most drapers' shops? It seems obvious that there are three classes of rules : first, the general regulations of the Board of Trade, issued with a view to safeguard the persons of the public, whether consumers or not, and to ensure a good and reliable supply to those who desire to utilise electrical energy. Then the station engineers have to insist upon certain broad conditions being observed by consumers, so that they may have a fair chance of meeting their obligations under statutory powers. These may be called "supply rules," and should be framed so as not to worry and annoy the consumer. Thirdly, the fire risk must be guarded against by proper wiring, and the fire offices who insure are entitled to state upon what conditions they will accept a risk, but such requirements should have a reasonable scientific basis. As Mr. Broadbent puts it, although the Phœnix rules fill 39 pages, one cannot gather from them any more idea of what would satisfy the technical officer of the Phœnix Company, than he has of the inhabitants of Mars. "Not one electrician in a hundred could define exactly what is and is not in accordance with these rules. They are not rules : they are exceptions and contradictions." It is perhaps reasonable enough that fire office surveyors should say they pay the piper and should call the tune, but it is quite another matter when station engineers want at the same time to call another tune.

The Board of Trade regulations say that in delivering energy to consumers' terminals, the undertakers shall exercise all due precautions so as to avoid risk of causing fire on the premises. This refers, however, to the work for which the undertakers are responsible, and which they own. The only other statement made in the regulations is that supply shall not be given when a leakage of more than $\frac{1}{1000}$th part of the maximum supply current is found to exist on the interior wiring. With what then is the supply engineer really concerned ?

The starting and stopping of motors and arc lamps or photographic flash apparatus may, and often does, seriously —or at least appreciably—affect the pressure on distributing mains. This is got over by running separate power mains, and by sub-dividing wiring circuits. The "supply rules" should state exactly what provision must be made in each of

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these cases, and define the current supplied per service and per branch circuit. Notwithstanding, theatres will switch off the whole of the floats, battens, and proscenium lights simultaneously, and undue pressure on the part of the supply people will only help the contractor who is anxious to get an order for a private plant. This is one of the things in London which electricity supply companies are finding out, and five minutes' conversation with an architect who is known in the theatrical line would make the matter very plain indeed.

Another point is the splitting up of house circuits for balancing purposes on a three-wire distribution. Bad balancing has been the curse of low pressure supply, and too great a reliance has been placed upon the carrying capacity of the neutral conductor. To remedy this the only radical cure is to balance half a house against the other half. Then one has to face the stipulation of the Board of Trade that the two pairs of a three-wire system carrying over 250 volts shall be brought into a building at points 6 ft. apart and kept quite distinct throughout the building. How, then, are the switches to be mechanically coupled, and what becomes of the "three-wire distribution boards" now on the market? These are further matters for "supply rules" to specify.

In short, the legal responsibility of the supply company ends at the consumers' terminals, and the only other questions which should be dealt with in "supply rules" are those which enable good supply to be ensured, because the consumer holds the suppliers morally responsible for his light or power. Therefore consumers' main fuses should be prohibited and the undertakers provide proper fuses in their terminal box. If anything goes wrong the fuses on the distribution protect the consumers' wiring. Main fuses when put in should have the tin or alloy wires removed and copper strips inserted; then they become test or disconnecting boxes only and give rise to no trouble. Earths or leakage faults, of course, have to be "ruled" against; with these the list comes to an end. If further protection be desired, the Institution Wiring Rules might be bound up with the "Supply Rules," and a few extracts from the Board of Trade Regulations would make a sufficiently imposing document without going outside reasonable limits.

There is too much tendency to regulate the consumer, and this does not help the electrical industry. The fire aspect is improved by the action of the Fine Art and General Insurance Company, which now gives a rebate upon the premium to clients using electric light. This is certain to be followed by the older and more conservative offices, and will be a boon to canvassers, who are often met by the argument that if all these rules are necessary electric lighting must involve grave risks; while if such stringency is not essential, why is the consumer harassed and bothered by his fire office and by his supply company to put in all sorts of fancy articles, to build brick boxes for the electricity meters, to case in the service lines with boiler plate, and so forth?—A question not always answered to the satisfaction of him who asks.

L.C.C. ELECTRIC TRAMWAYS.

The question of the London County Council conduit has brought the matter of such construction prominently before the public. Naturally, there being no electric conduit roads in operation in London, there has been a mass of criticism, both favourable and unfavourable to this conduit, which, for the most part, has come from engineers with little or no actual experience, or even knowledge of the subject. Consequently, however faulty the L.C.C. design of conduit may be, this criticism has not been of a nature to bring out prominently its real weaknesses. Furthermore, other ideas have been advanced as to what was proper and not proper in good conduit designs, which, not being based on actual knowledge of the subject or acquaintance with what has actually been accomplished elsewhere, give quite erroneous impressions. The essential characteristics which govern a good conduit design, have been, in consequence, rather lost sight of. We, therefore, have thought it well to repeat and amplify the brief criticism which we made some weeks ago on this important matter.

The first and most important point of construction is that the conduit should have the requisite strength to withstand all the forces to which it must be subjected. The width of the slot being so restricted, it does not become a question of breaking strength of the yokes, but one of stiffness, and again, this stiffness offers little or no resistance to slot closure between the yokes.

It is necessary therefore that the yokes should be sufficiently rigid; that the slot rails should be designed for lateral stiffness, so as not to deflect between the yoke supports; and, furthermore, that the yoke spacing should be small, so as to reduce this tendency of the slot rail to close between the yokes. Whether the yoke design involves the carrying of the track rails or not is absolutely immaterial, as far as this question of slot closure is concerned. That arm of the yoke which projects outwardly to form a seat for the track rail is metal thrown away for this purpose. Where yokes break and bend is at or near their lowest point, and not at the top where all this mass of extra metal is put in the form of an arm to carry the track rail. The practice of making yokes which carry at the same time the track and slot rails came originally from American cable roads; it was thought that the clearance between the grip and the carrier wheels being so little, it was necessary to preserve accurately the relative positions between these wheels and the car wheels, by making the track rails an integral part of the metallic structure. It was never pretended that the yoke arms necessary for this purpose gave any additional strength to the yoke to resist the pressures tending to close the slot. The construction has, further, an advantage in the actual building of the road, it being somewhat more simple to tie the metallic structure together, suspend it, and then concrete it in place; but to say that such yokes are essential to a good conduit construction is an absurdity, and it only needs an inspection of such roads as are at present in operation in Brussels, Berlin, Buda-Pesth, Vienna, and Paris, to prove this assertion. It can further be said that the best and most advanced conduit construction to-day would be with yokes carrying simply the slot rails, of stout heavy design, and spaced close together. If the L.C.C. yoke is weak and crude in design, this does not mean that the general principle involved in this type of yoke, which simply carries the slot rails, is not good practice. As a matter of fact the criticism which has been so freely made on the L.C.C. yokes has been mostly upon this point, and it has evidently been made by engineers who are familiar only with American practice, and are not conversant with the successful conduit constructions on the Continent. We know of an instance where yokes carrying the track rails, weighing 320 lbs. each, and spaced 4 ft. 7 in. centre to centre, have given trouble due to slot closure, from the expansion of wood pavement, while other yokes weighing 210 lbs. which only carried the slot rails, with spacing of 3 ft. 6 in. centre to centre, and subjected to precisely the same conditions, have stood without giving the slightest trouble from slot closure. The slot rail should further be tied strongly near its top to the yoke by tie rods, and the construction should be of such a nature as not to interfere in any way with the paving of the roadway. Ordinarily, designers of conduits who have had no practical experience with them pay little or no attention to this question of paving, but it is one which is well worthy of consideration. To have to cut the paving blocks in all sorts of shapes and to all sorts of depths, to go round or over projecting lugs and other obstructions on yokes, is a thing that can be done, but with a sure result of poor pavement requiring constant repairs.

The L.C.C. conduit design is fatally weak in regard to insulators. If there are any features of a conduit which, more than others, are recognised as being essential to good working, they are that the insulators should be vertically suspended and ironclad. This form of insulator has the advantage of being reliable to such a degree that it may be considered a standard by experienced designers of conduits. Actual practice to-day showing nothing equal to this type of insulator, it would be folly to make a retrograde step so far as this important part of the road is concerned. To fasten an insulator to the bottom of the conduit is to lay oneself open to the practical certainty of failure. In cleaning the conduit, the mud which is confined in the narrow cross-section of the tube between manholes expands and dumps

into these during the process. It has always been a source of annoyance to keep such manholes clear. Imagine what would happen with the insulator block sticking up from the bottom of them; there would be an enormous leakage, if not positive short circuit, occurring frequently, and causing annoying, even disastrous, stoppages on the line. The L.C.C. insulator has also the objection of being unprotected. The covers would be frequently raised by ordinary workmen to clean the dirt and mud from these little manholes, and it does not require much imagination to see such men constantly breaking the frail exposed porcelain insulators. Besides, the insulator has two joints half way down its length, through which moisture and dirt can creep, and it would only be a question of time when they would be leaking in their centre, and finally short-circuiting, the effect of which would be to break the insulators and stop the traffic. In fact, the whole design of the insulator is crude, and seems to have been got out with the express desire to make something different from that which has been successfully tried, and that with no knowledge of what are the essential requisites of a good insulator for a conduit electric road. This is simply to court another dismal failure, and the list of such is already a long one. There has been published a design of another system in the technical press within the past few weeks, which also shows a lamentable ignorance of the prime requisites of a successful insulator. Through the body of this insulator the bolt passes, and its head is exposed. It would only be a question of time when the dirt and moisture crept into the joint of the protecting piece, with the sure result of heavy leakages, and finally short circuits.

Too much attention cannot be given to the size of the conduit. This should be of such a shape as to allow at least a 2-in. air-gap all about the conductor bars. Further than this there should be a clearance of 9 to 10 inches underneath these bars. Where obstructions occur, which are not readily removable, this distance can be reduced, but such lengths of conduit should be as restricted as possible, as they require special attention in cleaning, and so are a source of extra expense. Such shallow lengths should also be specially well connected with sewers. The bottom of the conduit should be of as large a cross-sectional area as can be reasonably obtained. It is of no practical use to make the conduit in the form of an egg-shaped sewer, on the principle that it will be self-cleansing; no conduit can be self-cleansing. The large amount of heavy mud, and the small amount of water which enter through the slot, will not allow of cleansing by any other means than mechanical pushing of the dirt by means of special brushes to catch-basins. Therefore, a conduit which gives the greatest amount of room underneath the conductor bars is one that requires the least cleaning, and will have the least danger of flooding.

We note that in the discussion of conduits in the technical press nothing is said about the special track work, such as points, nor the plough.

It ought not to be particularly difficult to design a good straight track section of conduit as a result of all the experience that has been gathered by the successful installations now operating, but all experienced engineers have had their greatest difficulty in designing the slot points and the plough. These are the most troublesome matters connected with conduit roads, and we hope that they will receive the attention they deserve. None of the claimants up to the present time has seemed to consider these questions worthy of attention, but the design of such details makes for success or failure.

INSULATION ON CABLES.

On Thursday evening last week Mr. Mervyn O'Gorman read in abstract his paper bearing the above title, which provided the Institution of Electrical Engineers with scientific matter of a high class, but the discussion was curiously short compared with the energy thrown into the debate upon Mr. Madgen's views of the events "before and after" the Power Bills of 1900.

In Sec. 59 of Mr. O'Gorman's paper he attributes to Prof. Perry the suggestion that in the case of two or three-phase cables a thin sheet of high-resistance metal should be laid across the section of the model of the cable, and equipotential lines pricked off by aid of needles joined to a galvanometer. Mr. F. Jacob wrote to point out that he had applied this method in 1896 to the experimental determination of such problems,* and that the Electrical Review of that year contained an article by him on the subject.

Mr. Swinburne, while sorry that the paper of the evening had not been read at length, thanked the author for so generously acknowledging his paper given to the Engineering Conference, but it was his own fault if that paper had excited little attention, for it was absolutely unintelligible as read, and no one knew in the least what the paper was about. (This paper was published in the Electrical Review of June 16th, 1899. We took exception to Mr. Swinburne's treatment of the subject, and dealt with it in our issue of July 7th, 1899.) Mr. O'Gorman had taken that paper and developed it. He could not, however, think but that one may get into difficulties with some of these matters in attempting to cook the fall of potential by altering the specific resistance of different parts of the dielectric, as it may not be possible to alter the resistance without also affecting the dielectric strength. The really best cable would be a compromise, and the result of experiment from layer to layer. A good deal might be done by altering the dimensions of the cores. The problem resembled the designing of a gun, but what was wanted was something after the nature of a wire gun. A tear in the internal part of the dielectric might easily run to the outside, owing to the resulting very rapid potential gradient. These problems were very tempting if one used mathematics, but he hoped that they would not get into the hands of mathematiculists, and to the condition of alternating current theory. Many ordinary ways of testing were not known to many ordinary people, and credit for his suggestion was due to Prof. Perry, as it was just as difficult to re-invent a thing as to invent it. Unbleached insulating material seemed the right thing to use, but he had found a heavily-sized paper known as "butter skin" very cheap and good as a dielectric. Mr. O'Gorman's paper was the first really scientific paper that had been written on the subject of cables; how important the subject was must be evident from half the capital of electricity supply stations going into mains and cables.

Mr. Charles Bright thought it redounded enormously to the credit of the Deptford people that they should have used paper at Mr. Ferranti's suggestion so many years ago. Rubber had been shown by Sir William Siemens to absorb water.

Mr. Addenbrooke pointed out that on power transmission schemes it was simply wonderful what could be done if only copper had to be dealt with, but in this country the position was difficult, as the question of insulation came in, and there was nothing more serious between engineers and objects of the greatest industrial importance. He wondered that the whole subject had not been taken up, and urged cable makers—now very wealthy—to conduct experiments which were bound to result in very great improvements.

Mr. Kingsbury congratulated the Institution on the presentation of the paper, but thought that the idea of manufacturers practically endowing research was like the remarks of authors about publishers. It was hardly a fact that purchasers did not care what they bought, nor that cable manufacturers were careless. A maker of cables manufactured them for a living, and sold what he believed in; the purchaser bought what he knew to be durable, or something for which he was willing to take the maker's guarantee.†

Mr. Ferranti was sure that all cable-makers would be interested in the paper. Great care was taken in making cables to turn out the very best thing, but even the leading cable-makers had no secrets, the process was essentially a financial operation with a view to a lasting business. The style and class of cables, as well as the pressure employed,

* "The Capacity and Resistance of a Core with Eccentric Conductor." F. Jacob, Electrical Review, Vol. 38, No. 960, p. 497, April 17th, 1896.

† This remark is very true, and we would like to add that if consulting engineers would consult cable makers, simply specifying what cables had to do and not how they were to be made or what they were to give as tests, the benefit to makers and users would, we believe, be a mutual one.

were interesting in power schemes, as they depended on the size of the project, and the number of points to which power had to be taken. Copper was often quite a small factor, and insulation much more serious. In many cases the pressure chosen was that most economical to start with, but it did not remain the best to work with later on. It was a matter of good judgment, and required a financial sense with a prophetic eye to the future. The Board of Trade rules seemed to require too great a thickness of insulation on large cables, and this added not only to the cost of insulation but also to the sheathing.

Mr. E. K. Scott spoke in favour of the semi-solid type of insulation, like the Brooks's main, as it was all oil, and with paper it was the oil that was depended on for insulation.

Mr. Raphael did not fear degradation, but perhaps stagnation in the British cable industry. He discussed the advisability of adopting an insulating material, which sealed up a fault if by any chance the current sparked through, and instanced his own experience of the difficulty such faults presented when he came to localise them. He considered a high factor of safety was called for in dealing with complex organic compounds not easily reproducible with accuracy.

Mr. O'Gorman agreed with much that had been said, but in replying, pointed out that the cost of copper in high tension cables is nothing compared with the stuff outside. If a cable had a fault which was sealed up by the insulation, and remained sealed, that was an end of the trouble. While it is good to have a high insulation resistance, it was useless to argue that low insulation was unworkable; all depended upon the permanency of whatever the insulation was. He thought the insulating material must be mechanically strong to be electrically strong, and this apparently explained why the Brooks's main was little used. The idea of grading a cable did not involve any new material, but merely rearranged the existing materials. This closed the reply. It was quite apparent that very few present had really mastered the paper, and we trust that Mr. O'Gorman will seize every opportunity of expanding the views given in it; as an old cable man, he can speak from experience, and his originality of thought makes him just the one to keep the subject alive until deeper and closer attention has been paid to it.

OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be as brief and concise as possible. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

"Ebonite" writes:—"I wish to know whether, when an application for a patent is granted by the Comptroller-General, such granting means that the Comptroller-General has looked through previous records and has found the invention to be entirely new and original before granting it as such. Or whether, after the granting of the application, the person applying takes all risks. In fewer words, kindly say the strength of the granting of and application for a patent, and if granted after the two months of public inspection, is it perfectly secure?"

*** So far as we have been able to gather the meaning of the question put by our correspondent, an answer might almost be furnished by a cursory glance at the list of patents which are granted by the Comptroller from time to time. Were any duty imposed upon that official of investigating the novelty or utility of every so-called "invention" which is brought before him, his labours, and those of the staff employed by him, would be increased a thousandfold, while the number of patents issued would be diminished in proportion. An applicant at the Patent Office obtains provisional protection for a sufficient period in order to enable him to work out his complete specification. During the period of provisional protection his invention cannot be pirated by the public. After the filing of a complete specification he is in possession of a patent, the validity of which, as so many know to their cost, is not guaranteed by the Patent Office, but can always be questioned in subsequent legal proceedings. We might add that it has often been proposed that the Comptroller should be empowered to exercise some discrimination, in order to protect the would-be inventor from incurring the expense of obtaining an invalid patent—but hitherto the Legislature has consistently refused to entertain any scheme of the kind—although the revenue is yearly augmented by thousands of pounds received at the Patent Office in respect of absolutely worthless inventions.

INSTITUTION OF ELECTRICAL ENGINEERS (BIRMINGHAM SECTION).

The inaugural meeting of this Section took place on the evening of Wednesday, February 27th, at the University Buildings, Birmingham. The Chairman of the Section, Dr. Oliver Lodge, presided.

The Chairman said the inauguration of the Section was due to the efforts of Mr. Henry Lea and Mr. J. C. Vaudrey. Mr. Lea, as vice-chairman, and he (Dr. Lodge) had been asked to take the presidency for a short time. He was very glad that the branch should meet in the buildings of the University, and he hoped they would always continue to do so. It was the wish of the University and all its members to keep in touch with all the higher life of the city and surrounding district, and with none more than with the engineers.

Mr. Henry Lea explained the beginnings of the local organisation. In response to circulars sent out to the members of the Institution in Birmingham and district, including the Counties of Warwick, Stafford and Worcester, 79 replies were received promising to render assistance, and the Section was at once created. They were most fortunate in obtaining the consent of Dr. Oliver Lodge to become their first chairman. He (Mr. Lea) was appointed vice-chairman, and the Committee was appointed as follows:—Mr. F. Brown (Walsall), Mr. Alfred Coleman, Mr. Alfred Dickinson, Mr. G. S. Ram, Dr. Sumpner, Prof. Threlfall, Mr. Wyld, and Mr. Vaudrey. The hon. secretaryship had been taken by Mr. D. K. Morris. It was proposed to meet monthly on Wednesday evenings.

Mr. Vaudrey said the membership of the Birmingham section had now increased to 110. Birmingham and the district were rapidly becoming a very large centre of electrical industries, and the section was started with a view of bringing more nearly together those interested in electrical and kindred pursuits.

It was resolved that the present officers remain in office for the Session 1901—2.

The Chairman then delivered his inaugural address. He congratulated the parent Institution on its wisdom and enterprise in forming local branches, and on their system of publishing and utilising papers communicated. A multiplicity of publishing centres was bad for science. At the same time excessive centralisation and lack of stimulus to exertion at local centres was, if anything, a greater evil. By the present action of the Institution of Electrical Engineers both evils were avoided. Dr. Lodge afterwards proceeded to discuss the mutual compatibility of pure science and practical engineering, expressing himself warmly in sympathy with the movement prominently identified with Prof. Perry, in favour of reforming mathematical teaching. Euclid himself was splendid; so was his book, but it had had its day, and for elementary and popular purposes should cease to be. We were too busy nowadays to have time to cross every river by ascending to its source and walking down the other side. Professional guides along the old river path still attempted to hide the bridges, because if they were too easily seen, their occupation would be gone. But the bridges were there, and sooner or later even schoolboys would be permitted to make use of them, and enjoy the country on the other side, without spending all their days in a toilsome and deterrent mode of getting there over a route approved by the ancients. If there were any workers in engineering or any other branch of technology who affected to despise pure science—they were hardly worthy of notice—it must be affectation. It was to be heartily admitted that the enlarged experience, and the large-scale experiments rendered possible by the wealth of communities, who applied science to their own convenience, reacted with immense advantage on pure science itself. Meanwhile the justification for all pure dry science lay essentially in its ultimate human bearings. Again and again had the most unlikely channels developed into fruitful streams. The almost despised and neglected subject of electrostatics was again pressing to the front. The experiment of a charged rod and pith balls was typical of much that went on in electricity; but even before they understood the nature of an electric charge they would find that the labours of J. J. Thomson had enriched the science of our times with what appeared likely to be a unifying and comprehensive generalisation such as philosophers of all time had groped after.

At the conclusion of his address the chairman illustrated by a few simple experiments the most recent views of the passage of the electric current through liquids, solids and gases. They had been taught that they could only have conduction of electricity with matter and that through absolute vacuum electricity could not pass. It passed in the liquid with the atom; it passed in the solid from atom to atom; how did it pass in the gases? Dr. Lodge showed the electric discharge in a Crookes's tube, deflecting it with a magnet, and observed that that was one of the most extraordinary phenomena. They saw there the nearest approach to the electric current itself. There electricity was conveyed without matter, it was a disembodied electric charge. The atom was ordinarily associated with a charge, and force was required to separate them. This atomic charge when separated was known as an electron. Here, then, was a flow of electrons by themselves. A revolving electron was a magnet. A vibrating one started light vibrations. The electron, Dr. Lodge said had many of the properties of matter; for himself he felt that it had all the properties of matter. Inertia, the fundamental principle of matter, had now begun to be explained. When first met with in electricity it was not called inertia, it was called self-induction. Self-induction was going to explain, he believed, the inertia of matter, and the law of motion itself. It remained to be proved that the atom was composed of electrons,

that the whole of matter was unified, that the different kinds of atoms only consisted of different numbers of electrons.

Prof. Perry proposed a vote of thanks to Dr. Lodge for his address. He thanked the chairman for his references to himself, observing that engaged in the crusade in which he was engaged, and subject to much adverse criticism, praise of the kind he had received from Dr. Lodge was of great value to him. All the scientific world was watching to see what Dr. Lodge was going to make of the great problem that had been set before him in the Birmingham University. Prof. Perry went on to deprecate the tendency in the parent Institution to array professors and engineers against one another, and advocated the cultivation of a spirit of mutual helpfulness, as between men whose various endowments must be inter-dependent if they were to be fully utilised. Referring to the untimely death of Prof. Fitzgerald, the speaker delivered an eloquent panegyric on his worth and his work. With regard to the prospects of the Local Section of the Institution they were now inaugurating, it was a great advantage to the members to be working in Birmingham. The Birmingham people were the first people in the world, he believed, to go in for the science of manufacture, probably the most important science of engineering at the present time.

Prof. Threlfall seconded the proposition, and expressed his concurrence in the condemnation of the prevalent system of teaching mathematics in public schools, but said he did not endorse the perpetual tilting at their old friend Euclid. It was not so much the study of Euclid, but the setting up of algebra as a sort of puzzle for tripping lads, that was to be reprehended. Dr. Lodge was now devoting himself to the development, on new lines, of a University untrammelled by a past age. They must all wish him "God speed" in his work.

The resolution of thanks for the address was enthusiastically adopted.

As a close personal friend of the late Prof. Fitzgerald, the chairman, before concluding the meeting, testified to his distinguished services to mankind, as well as to the human and domestic virtues which illumined his life.

ELECTRIC LIGHT CHARGES.

We mentioned last week in our "Notes" that a conference was held at the Board of Trade on 6th inst. of representatives of the London County Council and London and country electric light supply companies and others with reference to the proposal of the Board of Trade to reduce the *maximum* charge for electric lighting from 8d. to 6d. per unit. For the following summary of the proceedings we are indebted to the *Times*.

Sir Courtenay Boyle, who presided, said they were met to reconsider the *maximum* price which the Board of Trade should put into the electric light provisional orders before Parliament this session. The Board had sent round a notice to the effect that they thought the *maximum* of 8d. per unit should now be reduced. The Electrical Engineers' Institution had urged reasons against the reduction this year. The London County Council, on the other hand, supported the reduction.

Colonel Crompton, on behalf of the electrical engineers, said they considered that the proposal to reduce the *maximum* charge would prevent electric lighting in small country places. There were two distinct classes of orders for electric light. There were those for populous districts, and the orders from those parts of the country which had not yet got the electric supply. The very small advantages to be gained by reducing the *maximum* in every district could not be weighed against the disadvantages of preventing the installation of electricity all over the country. The reduction could not result in any great advantage to the community in general, and the Board of Trade should hesitate before enforcing the regulation.

Mr. Mordey also spoke for the electrical engineers.

Mr. R. P. Sellon, chairman of the electrical section of the London Chamber of Commerce, said that in many cases people in small districts would be willing to pay a shilling or more per unit in order to have the electric light. The proposed Board of Trade regulation would render it impossible for a corporation or a company to instal the light for a widely-scattered population where it would be so acceptable. He thought that in certain cases a high *maximum* should be allowed.

Mr. Sydney Morse, Mr. Wakefield and Mr. Pritchard and others having spoken against the proposed reduction, in the interests of various bodies having to do with the electric light,

Mr. Blaxland, for the London County Council, said the contention of the Council was that the average *maximum* price should not exceed 6d. per unit. For instance, the regulation might allow of 7d. per unit for the first year, and 5d. or 4d. in subsequent years, but their desire was to have an average *maximum* of 6d. per unit.

Sir Courtenay Boyle, in reply, said that the Board of Trade was not in the least disposed to take any step which might discourage the provision of electrical energy. On the contrary, they were most anxious that every facility should be given to encourage in the best way possible the development of electrical science and electrical distribution. They therefore would not lay down any hard and fast rule. They did think, however, that the normal 8d. per unit was too high. The Board said that very deliberately, so that that expression of opinion might sink into the minds of gentlemen concerned in the promotion of provisional orders. But as regarded this year the Board would not adopt a hard and fast rule. In small places it might be left open to the promoters to show reasons why an 8d. *maximum* should be kept up, but the onus of proving that lay upon the promoters. The Board considered that anything which they could do to encourage the *maximum* demand and supply ought to be done. The decision of the Board would be this—that it would not be a hard and fast rule to reduce the 8d. per unit to 6d., but where good cause could be shown for an 8d. or 7d. *maximum*, with or without the sliding scale arrangement, the Board would take into their careful consideration the representations made to them on that behalf. He merely wished to point out one thing—viz., that the wholesale consumer took care of himself, but that the small retail consumer who wanted electrical energy for a short time, and in a small quantity, must rely upon the *maximum* limit of charge. He had nothing else to rely upon.

Mr. Blaxland: The normal price is to be 6d., and the onus rests upon the promoters if they want more.

Sir Courtenay Boyle: No: I should think a 7d. *maximum* would be adopted in a normal case. In very large populous places we shall try to adopt a 6d. *maximum*, in ordinary cases, 7d. In special cases cause must be shown why it should be 8d.

Colonel Crompton, on behalf of the electrical engineers, said the decision was very satisfactory to them.

THE BOARD OF TRADE INQUIRY re ELECTRICAL PRESSURE.

(*Continued from page* 435.)

At the opening of the resumed inquiry on Thursday in last week, Sir Courtenay Boyle again presiding, the President said he had to rule that the Board of Trade had power to alter both the proviso and the award.

Mr. Moon, in opening the case for the Chelsea Company, said that his company did not work under the same difficulties as the Westminster company as regarded having to meet extortionate demands on the part of consumers. At present they had no obstructionists standing out in Chelsea, but they had 500 100-volt consumers, and what they were afraid of was not that they might prove obstructive, but that, through being misinformed as to the effect of the change, they might object to it. There was an idea in some people's mind that the higher voltage was dangerous, and others were afraid that the alteration would involve great disturbance of their premises. Under these circumstances the company thought it was not a case in which the veto should be placed in the consumers' hands, but it should be in the hands of an independent arbitrator.

Replying to the President, Mr. Moon said he was not sure whether they had got the consent of the L.C.C. to the proposed change. He did not think in the case of the Chelsea Provisional Order the County Council had the same power that they had under other orders.

Mr. Percy Still, the chief engineer to the Chelsea Electric Supply Company, gave evidence as to the system adopted by that company for supply. He said that they gave a continuous current supply on the three-wire system at present, so that they had 200 volts pressure on the outside wires and 100 volts between the two adjacent wires. They generated at 1,000 volts pressure and transformed down to 200 and 100 volts. The benefit to the company, as far as capital outlay was concerned, in converting the whole of their system to a 200-volt pressure would not be so great as in the case of the Westminster Company. So long as they had any 100-volt customers left, they would have to keep a separate system of mains for the continuous supply of those customers and a separate plant, or to introduce motor transformers in the consumer's premises. That would involve considerable extra expense in the cost of supply.

Is it, in fact, more expensive to supply 100-volt current to your consumers now than to supply the 200-volt current?—Yes, it is. The loss in distribution is very much greater with the 100-volt supply than with the 200-volt supply. The principal reason for the extra cost lies in fact that we cannot make use of the advantage of the present capital expenditure in our mains to the full extent. Continuing, witness said that they would be able to put two or three times as many lamps on the same wires if they were enabled to increase their pressure. The relative cost of supplying consumers at 100 volts continued to increase as the number became smaller and smaller. Altogether they had a total of 2,082 consumers, and of those 1,516 were supplied with current at 200-volt pressure and 566 with the 100-volt current. About 500 of their consumers voluntarily changed over from the 100 to the 200-volt supply. They had not attempted to urge their consumers to come over in any way to the 200-volt supply; it had been simply a voluntary action on their part up to the present. They were able to supply the current on better terms to those who took the 200-volt supply. Their charges were 6d. a unit for 100-volt pressure, and for the 200-volt pressure they charged on what was known as the maximum demand, which was first in use at Brighton, and in their case the charge for the units corresponded to the maximum demand during an average of 1½ hours per day—that was 6d., and any units used beyond that amount were charged at 3d. The adoption of that system had caused them a considerable diminution in their receipts. The average price paid last year was about 5d. per unit, and that meant a reduction of about £3,000 in the charges of the company. Their maximum power of charge was 10d. per unit. The 6d. per unit which they charged to 100-volt consumers involved a loss to the company, and therefore they had issued a notice that on and after July next the charge for the current would be 7d. per

unit, and as the numbers taking the 100-volt pressure got fewer and fewer, they would be compelled to make the charge higher and higher to cover themselves. The existing installations in the houses, if they had been properly carried out, would enable the consumers to put more lamps on their installations without any alteration if they were supplied at a higher pressure. Regarding the question of saving on capital outlay, it was rather a difficult thing to calculate in the case of their company, but he should say that during the course of the next 10 years they would make an average saving of about £5,000 and £4,000 per annum. At present that was a wasteful expenditure from the point of view both of the company and the consumers.

Mr. S. Baynes, electrical engineer to the borough of St. Pancras, said that when that body started supplying electricity, they commenced supplying at 110 volts pressure. Since that time it had been doubled, and he believed they were the first undertakers to supply at 220 volts. Nearly all the consumers took the new supply, but one stood out, and it had cost the borough over £2,500 to provide mains to continue to supply that one man. In the interests of the supplier, as well as the consumers, it was necessary that the power should be taken out of the consumers' hands and vested in the Board of Trade. He agreed that there would be considerably economy in working, and that there was no danger from the increased voltage.

Mr. Massey, who appeared for the Crown, said that if the Board of Trade granted the request of the companies, there should be a provision added that none of the cost of the conversion should be borne by the consumers. If the wiring of the 2,000 or 3,000 lamps in the State rooms of Buckingham Palace had to be overhauled, the cost would be about £1,500, and there were many buildings besides the royal palaces where very considerable expenditure would be entailed, and it was not right that the consumer should have to pay for that.

The inquiry was adjourned till Tuesday.

At the resumed sitting of the inquiry on Tuesday, Mr. Danckwerts opened the case for the City Corporation, who are opposing the application of the companies. In the course of a long argument, Mr. Danckwerts said that the companies were not entitled to change the pressure which they had declared, unless it was made necessary, or was in consequence of some change in the standard pressure, and he maintained that they had not made out either of those propositions. All they said was that they could not supply the two pressures on the same mains, but that it would necessitate the installation of transformers in some of the consumers' premises. He could have understood the position of the companies if they had asked the Board of Trade to remodel the whole of the clause; but it seemed illogical to ask simply for a change in the proviso. The companies had admitted that by continuing the mains, some at a lower pressure and some at a higher, that they would be able to continue to supply the two voltages, and Sec. 4 of the regulations expressly contemplated their having mains of different standards. Further than that, they admitted that they could, either by the use of transformers or by sub-stations, continue the supply at a lower pressure, and therefore the alteration sought for was one merely for the convenience of the companies and for the saving to them of capital expenditure. He submitted that no good case had been made out to warrant the Board of Trade altering the proviso. In the case of large consumers and public bodies such as the London County Council, the City Corporation, Buckingham Palace, large hotels, &c., there would be no difficulty whatever in having the transformers on the consumers' premises, and in other cases what was there to prevent the companies grouping the consumers together and supplying them at a lower pressure by means of transformers? That could easily be done if the companies so desired, but the truth was that they wanted to make this change, which was for their own benefit, solely at the expense of the convenience of the consumer. But supposing the Board of Trade considered that the proviso should be altered—he would ask, were the changes to be made irrespective of the number of consumers who were holding out? He (Mr. Danckwerts) submitted not. He could conceive that where there were one or two, or even a dozen, consumers at low pressure who were standing in the way of considerable improvement, that there was a case there for the intervention of the Board of Trade, and for that body to say whether or not it should be forced upon those consumers to change their supply, or whether or not there should be forced upon the company to adopt some means, like the use of transformers, to supply these particular consumers at their old pressure, or whether or not the consumer should be given the option of continuing his present supply upon the terms of having a transformer upon his premises. He could understand those questions being submitted to the Board of Trade when it was the case of a few people standing out, but in the case of the City there were in round numbers 4,500 consumers who came within the proviso, and surely it would not be right to force those alterations upon such a large number of consumers, purely for the benefit and for the convenience of the companies. That showed that there ought to be some limitation to be determined by some authority in every case as to whether or not the proviso should be dispensed with. For example, there might be a street in which there were, perhaps, 20 or 30 consumers having a reasonable number of lamps between them, and in that case the Board of Trade might very well, as a judicial and impartial body, say that the company should provide, by means of transformers, for supplying those people at their present pressure, and it might also be possible to arrange for the erection of transformers to serve a certain number of consumers in a district, although not in the same street. He would remind the President that Prof. Kennedy in his evidence had admitted that the change would not benefit the consumer, but that the people to benefit would be the shareholders of the companies, as far as regarded capital expenditure. It must always be remembered that companies who had appeared at that inquiry had never found any difficulty in supplying, notwithstanding the existence of this proviso, and therefore, if the proviso was to be altered it must be incumbent upon the companies to overhaul the consumers' fittings, &c., at their (the companies') expense. But then they might come to this point—that the company might say, "We have done enough, and we don't think that we ought to be required to do more," and in such a case he (Mr. Danckwerts) thought it ought to be in the power of the Board of Trade to say who was right, the consumer or the company, and to make an award accordingly. Then on the question of costs, any matter in dispute should be left to the discretion of the Board of Trade or the arbitrator.

The President: Why not apply the Arbitration Act of 1889?

Mr. Danckwerts replied that the objection to that course was that very often arbitrators split the costs between the two parties, and he submitted that in cases where a company was found to be wrong, they should pay the costs without any question of arbitration. With regard to the important question of lamps, he would rather that that should be settled by the Board of Trade than by the evidence of expert witnesses. The continuous test to which Prof. Kennedy had subjected the lamps upon which he had experimented was not a test which applied to every-day conditions of burning, when the lamps were being constantly lighted and relighted. He would suggest that the Board of Trade might carry out experiments in their laboratories with lamps.

The President: But the laboratory test is not an actual consumer's test.

Mr. Danckwerts said he meant that the tests should be as nearly as possible such tests as would cover the every-day conditions of lamps.

Mr. Balfour Browne said he would have no objection whatever to the Board of Trade making the tests suggested.

The President said he had prepared a clause which, he thought, might meet with the approval of all parties. He did not put it forward as in the least wishing to announce any decision by the Board of Trade, because, of course, any decision would be made by the Board itself. The clause he had drafted was as follows:—

"Provided that no change shall be made in the pressure of the supply to any premises which on were supplied with energy by the undertakers except with the consent of the consumer; but where the consumer withholds his consent after the undertakers have offered to pay the reasonable cost of, or incidental to, the change, the undertakers may appeal to the Board of Trade, and that Board may, if they think fit, dispense with the consent of the consumer on such conditions as the Board impose.

"The Board of Trade may, if they think fit in any case, refer to the arbitration of a single arbitrator appointed by them, the question of the conditions to be imposed under this provision.

"The arbitration shall be subject to the provisions of the Arbitration Act, 1889, as if the arbitration were pursuant to a submission, and shall also be subject to the like provisions as an arbitration in pursuance of a special Act under Part 1 of the Board of Trade Arbitrations, &c., Act, 1874."

Mr. Balfour Browne said he was perfectly willing to agree to that clause.

The Hon. A. Lyttleton said that in the event of the clause being accepted, he considered that the arbitration should be subject to the provisions of the Lands Clauses Act, under which Act no claimant could ever be made to pay more than his own costs.

Mr. Danckwerts said that he accepted the principle of the clause if there was to be any alteration at all.

Mr. Cross, on behalf of the consumers opposing the Westminster Company, was not disposed to accept the clause.

Mr. Balfour Browne said he must ask the President to stick to the arbitration clause he had proposed.

Mr. Roskill said that the clause would be acceptable to the City companies.

The President said he thought it would be desirable at that stage to adjourn, so as to give all parties an opportunity of considering the clause and submitting any amendments or additions they might think necessary.

The inquiry was then adjourned until Thursday.

CORRESPONDENCE.

Brighton Cable Tender.

Enclosed are copies of correspondence on this subject which may be of interest to your readers. I think the letters fully explain the position in which the controversy stands at present.

A. H. Howard.
Secretary Cable-Makers' Association.

Westminster, S.W.

[COPY.]

Town Hall, Brighton.
February 27th, 1901.

Dear Sir,—Your letter of the 8th inst., the receipt of which I acknowledged on the 9th inst., has been submitted to the Lighting Committee of the Corporation, and in reply thereto, I am instructed

to inform you that you are in error in stating that several of the recent tenders sent in for cables for the Corporation of Brighton were substantially lower in amount than the tender of the Union Cable Company, which was accepted; that when consideration had been given to the effect of the alterations made in the conditions by the persons and companies whose tenders were apparently the lowest, it was found by the committee that they were, in fact, not so, and that the Union Company's tender was undoubtedly the most advantageous to the Corporation.

I am further directed to inform you that the Lighting Committee of the Corporation are willing at any time to consider any suggestions made by the Association or any of its members for the alteration of the conditions attached to the specifications for the supply of cables for the Corporation, but they cannot consent to any alteration in the conditions, when once issued, being made by persons tendering, inasmuch as alterations so made would render a fair comparison of the tenders received exceedingly difficult, and perhaps impossible.

Yours faithfully,
(Signed) F. J. Tillstone, *Town Clerk.*

A. H. Howard, Esq.
Honorary Secretary,
Cable Makers' Association,
2, Queen Anne's Gate,
Westminster, London, S.W.

Cable Makers' Association,
2, Queen Anne's Gate, Westminster, S.W.,
March, 1901.

Francis J. Tillstone, Esq.,
Town Clerk,
Town Hall, Brighton.

Re Cable Tender.

Dear Sir,—Your letter of February 27th has been considered by the Cable Makers' Association, and I am requested to point out that the facts of the case do not support your contention that the foreign tender accepted was undoubtedly the most advantageous to the Corporation. This is shown by the prices of the various firms, as stated below:—

—	Cables.	Carriage on empties.	Total.
	£ s. d.	£ s. d.	£ s. d.
Johnson & Phillips ...	13,335 0 0	30 0 0	13,365 0 0
W. T. Glover & Co. ...	13,731 13 4	89 9 2	13,821 2 6
B.I.W. Co. (rail) ...	13,859 0 0	By rail £95	13,954 0 0
B.I.W. Co. (sea) ...	13,859 0 0	By sea £75	13,934 0 0
Foreign tender accepted, including carriage ...			13,952 0 0

The carriage on the empty drums given in the second column is obtained from the weight of the drums necessary, and the railway company's charges to each manufacturer's works; so that even taking into account this cost of carriage (which is assumed to be included in the foreign tender) there is a difference in price in favour of the lowest British firm of £587.

The only other point which might be taken as increasing the cost of the British tenders is the stipulation that if the drums are not returned, carriage paid, within three months from date of delivery, two-thirds only of the original price charged would be allowed. As presumably the extensions of the circuit are carefully planned out and the order of laying cables arranged, three months' time should be ample for emptying and returning drums; and the probable cost of keeping some few drums beyond the three months would be very small. But even if every drum were kept more than the stipulated time the one-third of the cost paid to the manufacturer would still leave Messrs. Johnson & Phillips's tender considerably below the accepted one. The total number of drums required would be 130. These would be of various sizes and prices; but the average price would certainly not be more than £3 per drum, or a total cost of £390. Assuming that none of these drums are returned within three months, the Corporation would have to pay £130 as a maximum charge. This would still leave Johnson and Phillips's tender £457 below that of the Union Cable Company.

Referring to your statement that the Corporation is willing to consider any suggestions for the alteration of the conditions, but cannot consent to any alteration in the conditions when once issued, it is obviously impossible for anyone to suggest alterations to a specification which they have not seen; and your proposition is untenable unless it is taken to mean that all tenderers must accept the conditions, however onerous they may be, and then ask as a favour that those objected to may be modified. I would point out that this is not a sound business proceeding, and any responsible firm would object to agreeing to conditions which they could not carry out.

The conditions of the Cable Makers' Association were published in October last. Copies have been sent to all consulting engineers and station engineers; among others to your consulting engineer at Brighton. They were, moreover, published largely in the technical Press. Therefore, so far as is possible, the suggestions which you say your Corporation is willing to consider, were made to your consulting engineer, and through him, of course, to you.

As you are aware, the Cable Makers' Association in dealing with mains for town lighting, has endeavoured to standardise the general conditions of contracts, but does not consider the question of price, so that in no sense could it be looked upon as a ring for obtaining excessive profits.

Maximum Price of Electrical Energy.

In view of the general interest created by the proposal of the Board of Trade to reduce the maximum price chargeable under Provisional Orders from 8d. to 6d., it may interest your readers to have the following copy of a clause suggested, after full discussion, by the electrical section of the London Chamber of Commerce in a recent letter to the Board of Trade, as likely to meet the views of the Board, without any prejudice to the interests of the electrical industry, and the use of the maximum demand system of charge.

The clause which was brought forward by Mr. Percy Sellon, representing the electrical section of the Chamber, at the meeting at the Board of Trade on the 6th inst., is as follows:—

Where undertakers charge any consumer by the actual amount of energy supplied to him, they shall be entitled to charge him at the following rates per quarter:—

For any amount up to 20 units, 13s. 4d., and for each unit over 20 units, 8d., provided that if any one year after the first complete year of working the general average price of electrical energy supplied for all purposes under the order exceeds pence per unit, then for the following year a reduction shall be made equitably calculated to bring such general average price down to pence per unit.

This suggestion appeared to meet with the general concurrence of the Board of Trade, and of the majority of those present.

Kenric B. Murray,
Secretary, London Chamber of Commerce.

March 6th, 1901.

"Stopping" Loads on Energy Meters.

We notice in your issue of March 1st an account of an interesting experiment made upon one of our meters by Mr. Campbell. Permit us to point out that the meter he employed was of a pattern we do not now manufacture, and that no amount of self-induction ever met with on ordinary circuits will cause the stoppage of our modern instruments. Meters of the kind Mr. Campbell refers to were sold as only suitable for use on circuits possessing no appreciable self-induction.

Chamberlain & Hookham, Ltd.

Depreciation.

I have read with considerable interest your article on "Depreciation," but cannot agree with your conclusions, as figures show that local authorities, certainly in the provinces, set more aside than any electricity supply companies I am aware of; nor do companies, so far as one can ascertain from their accounts, set aside any sum towards the sinking or redemption fund, whereas local authorities must do so, and therefore I consider a local authority is perfectly justified in treating this sinking fund as a redemption fund, and whether or not it is necessary to add to this amount set aside in order to increase the total amount put towards depreciation, must depend upon circumstances. However, for the present, in Tunbridge Wells, I am quite satisfied for the sinking fund to form the depreciation fund. If you refer to the companies' accounts, you will find that, with the exception of the Brompton Company, which sets aside 3·84 per cent., the St. James's Company 3·65 per cent., and the Westminster Company 3·56 per cent., all the other companies are in a much worse position with regard to depreciation than any local authority which has to repay its loan within 25 years.

The depreciation in Tunbridge Wells I have worked out as follows:—

	£
On the buildings I allow 1 per cent., which equals	61·97
„ machinery 4 per cent., which equals ...	531·76
„ mains 2½ per cent., which equals	363·60
„ meters 6 per cent., which equals	113·26
„ electrical instruments 5 per cent., which equals	7·71
„ public lamps 2½ per cent., which equals ...	64·20

which represents 2·83 per cent. of the total capital. It is true we did, in order to make ourselves doubly safe, carry forward a sum of £2,039 2s. 6d., but this was to meet any unforeseen emergency, and to prevent having to increase the price charged to consumers, should fuel or other items go up. However, from what I have seen, I am under the impression

—wrongly or otherwise—that the plant of a local authority at the end of a year's working, is kept in better order and repair than that of companies, as there has been no reason to stint the cost of repairs during the year, but every inducement to keep the machinery in thorough working order, which inducement is not so strong in company working.

The average price charged in Tunbridge Wells last year was 4·7d. per unit for private lighting, and 1·59d. for public lighting, which prices cannot be considered excessive with coal at 36s. a ton!

Horace Boot,
Consulting and Resident Electrical Engineer to the Tunbridge Wells Corporation.

March 6th, 1901.

May I be allowed to add the following remarks to those of Mr. David Urquhart on the subject of depreciation?

Most people will be disposed to agree with him that many modern engines will last 15 years or more; but age is not the only reason for discarding machinery, as Mr. Urquhart says. It is sometimes advisable to do so to secure greater efficiency. It would be very rash to prophecy that the plant which we consider to-day to be extremely good, will appear to us in the same light 15 years hence.

Cables, like accumulators, are difficult of assessment for wear and tear, although, of course, not in the same degree.

But there is another aspect to the question. In "strict justice" ought not appreciation to be taken account of? Land may increase in value to a very great extent; and it is *possible* for copper mains, &c., to do so too. Forty years is a long time to look forward to.

Under the circumstances would it not be more equitable to the present and succeeding generations to have a periodical survey, say every seven or ten years, with a new valuation and fresh start each time?

George H. Corringham.

[We deal with these letters in our leading columns this week.—Eds. Elec. Rev.]

Storage Batteries for Electrical Traction.

I have read with considerable interest your editorial comments on the paper I recently read before the Manchester Section of the Institution of Electrical Engineers, and while cordially thanking you for your general endorsement of the views expressed therein, I feel there are one or two points that you have very clearly misunderstood.

In the first place you take exception to my allowance of 7½ kw. per car. Actual experience has proved this figure to be nearer the mark than the 6 kw. you suggest, if all conditions of working are taken into consideration. Under special conditions your figure may possibly be obtained, but I should certainly be interested to know of a station where it has not been exceeded during a year's running.

So far as the cost of batteries is concerned, the figure I gave was in no way an estimated one, but is a figure that is daily being quoted, for reasonable sized batteries.

The whole question of the value of a battery on a line depends entirely on the employment that is made of it, and my objection to the use of a battery as a buffer simply, was certainly not based, as you state, on the fact that it required a careful predetermination of the characteristic of the generator—this was stated to be a necessity, not an objection—but for the reason that no adequate use could be made of it under these conditions of working.

Your surmisal that there must be the same drop of the line voltage as on the buffer system to enable the battery to discharge when used in conjunction with a reversible booster is totally erroneous, and I am afraid points to the fact that you fail to grasp what the special function of a booster of this type is, viz., at times of discharge to *add* its voltage to that of the battery, and so assist the discharge, and at times of charge to add its voltage to the line volts and assist the charge. As an actual matter of fact, there *is* no drop of the line voltage, the extra call for current from the battery and consequent fall in battery pressure causes the boost to increase simultaneously so that the line volts remain unaltered.

G. A. Grindle.

The Electrical Trades Union.

I have been much interested in reading the "proposed new rules" of the E.T.U. for the protection of "wiremen's interests" and the remarks and correspondence thereon.

I have myself been practically engaged in wiring, being also qualified to undertake dynamo erecting and repairs. I fully agree with "Jointer" about the class of men who are members of the E.T.U., having come into contact with many of them in connection with my work. Many of them require as many, and often more, instructions as to how to carry out some of their work, as an apprentice with six months' experience; these are the men who must be paid 9½d. per hour. I know several who have been made members of the E.T.U. as wiremen, who at the time of joining had not more than a few months' experience. I consider it a most unfair clause to the employer, that, as regards overtime, each day is to stand by itself, as there are many wiremen, who, having worked over one or two nights, would remain away from work a day or two and so be a source of loss and annoyance to the employer. I think overtime should not be paid until a full working week has been made, except in the case of compulsory holidays. My experience may have been unique, but when I worked on accumulator and similar jobs I asked for and received, without the slightest objection, an extra allowance, without any compulsion. As regards limiting apprentices to one for four men, I think that is absurd, and likely to be a source of friction, as in no trade more than wiring is the assistance of apprentices or other assistants more useful to a skilled man. Anyone who has been on large wiring jobs where there are numerous walls, which wires have to be put through, will see the time that would be wasted if a man had to wait for assistance till the other three men had done with the assistant or apprentice. I was never a member of any society, yet I always secured agreeable conditions of work.

Formerly a Wireman.

Seeing the letters in your journal relating to "Wiremen" I cannot help writing to corroborate "Jointer's" statements with regard to workmanship. I have served 12 months with a London supply station as tester in the change-over department, and have seen and condemned any amount of work which would have disgraced a year-old apprentice to the wiring trade.

The fact is, any man with a saw and mitre block can get engaged as carpenter to an electrical firm, and at the end of a year or less will blossom out as a full-blown "Wireman," another year will see him an "Electrician," and when he has seen a motor fixed he is an "Electrical Engineer." One man I know, now getting full wireman's pay, only a year ago was a porter in a railway goods yards.

While this state of things is possible we cannot expect to get good work. It should be made compulsory for every wireman to pass an examination in wiring, but at the same time he must be given an opportunity to do so. Otherwise all the writing to journals in the world will do no good. The City and Guilds and the Polytechnic already have examinations which serve all practical purposes.

Anti-Wire-buster.

Referring to last week's question, What is a wireman? I am very much interested, and "Jointer" has my sympathy. In my opinion 95 out of every 100 so-called wiremen are "scrap." I know that 6½d. an hour round Manchester district is an enormous salary. I was also a member of the so-called Electrical Trades Union (Salford Branch). I left the club-room one Saturday night in disgust; two accumulator jar washers-out made application for membership, and they were accepted. I myself am strongly in favour of Trade Protection, but it must be trade, not universal knobsticks. "Jointer" will find that good men can always hold their own against others; and as for Electrical Trades Union, there is none yet worthy the name.

J. Johnson Wood.

Broadway, Salford, Manchester.

May I, as a trade unionist, be allowed by your courtesy to criticise an article appearing in your issue of the 1st inst., and which to my mind, and that, no doubt, of many others, does us a grave injustice.

The writer of the article has undoubtedly some remarkable notions upon most matters he deals with, but particularly in regard to the qualifications necessary, and those possessed by the wiremen of to-day.

He would lead the uninitiated to believe that no skill whatever is required for the work undertaken by that much-abused individual.

It may be news to him to learn that we have little to settle with the other unions, and are on amicable terms with all. Respecting his contention as to our having to leave the cutting and screwing of iron pipe to fitters, the wiping of joints on lead-covered wire to plumbers, and the running of casing to carpenters, he is grossly in error.

I could name very many jobs where wiremen have worked all the iron barrel, and have not been interfered with by the fitters, and the same will apply to the plumbers and carpenters respectively. In fact, we claim the right (and our claim is respected by other trades) to fix any casing or piping of whatever material that is used as an envelope for wires carrying electric current.

It is a peculiar and interesting commentary upon another portion of his article to state that the proposed rules (though stupid) are those that have been in use for some years past by the best contractors. The rates of pay also are those that a fair proportion of London employers have been willing to pay, and have paid for some considerable time to skilled wiremen, who are not "half castes." And here I may mention that this appellation would apply to some contractors as honestly as it, unfortunately, does to some men.

But, sir, we contend that these "half-castes" are the creation of employers who work upon the lines suggested by your contributor, and again, are we really to believe that employers are so generous or foolish as to pay the wages they do for work that can be done—according to the article—by boys at, perhaps, a quarter of the rate that is paid to the man?

The "installation" laid out in the office is a novelty to most of us (except on very large jobs, where a consulting engineer is employed), and not being well acquainted with it, I refrain from comment.

The aim of our union is, and has been, not only to better the pay of the man and his conditions of labour, but also to better his relations with his employer.

I cannot do better here than paste into my letter "Clause 2," Rule I. of our registered rules.

"2. The objects of the Electrical Trades Union are:—By mutual effort to place ourselves on a foundation sufficiently strong to prevent further encroachments on our trade rights and privileges. We propose to establish an apprentice system, to maintain a higher standard of skill, to encourage the formation of schools of instruction in various branches for teaching the practical application of electricity and for trade education generally, to cultivate feelings of friendship among men of our craft, to settle all disputes between employers and employés by arbitration (where possible), to assist each other in sickness and distress, to secure employment, to reduce the hours of daily labour, to secure adequate pay for our work, and by legal and proper means to elevate the moral, intellectual, and social condition of all our members."

Yourself and readers will, I feel convinced, remark that the objects are good and commendable, and such as are acceptable to both parties. It would be well had we a little more encouragement from some sources.

I may say that in nine cases out of ten where an employer has applied and has been supplied with a man from our society he has been entirely satisfied both with his behaviour and workmanship, and has conclusively proved this by seeking our aid again.

This is evidence surely that the hostile attitude suggested by the article is unnecessary, and, if I may say so, the whole is a somewhat unwarranted attack upon a body of men (trades unionists in general) whom even the late Colonel Dyer proclaimed as beneficial and essential.

In conclusion, I may say that a trade union does not fix a man's rate, but merely fixes a rate below which he is not allowed to work (except in the case of aged men, who are usually allowed to get what they are worth).

The 10½d. per hour your contributor seems to think so exorbitant, is exceeded, and, I may say, doubled, by many of my fellow members.

With apologies for thus troubling you.

J. P.
(*A Member of the E.T.U.*)

Northwich, *March 7th*, 1901.

[The writer of the above letter, on his own showing, has had a very limited experience in electrical wiring work. Apparently he is not accustomed to working to plans, and considers an "'installation' laid out in the office a novelty to most of us"—*i.e.*, the members of the E.T.U. This simply proves that the unionist wiremen are not men of much experience. The facts which "J. P." styles "extraordinary notions" can all be very easily verified. In localities where the Trades Union system is strongest, it was not uncommon only a short time ago—in fact, it was a recognised practice—to prevent wiremen doing any work that could be claimed by any other trade unionist; and as the greater portion of installation work is certainly not simply wire-laying, it left very little for the wireman to do. If these restrictions are not insisted upon so much at the present moment it is undoubtedly due to the fact that trade is very good, and there are very few unionist members "on the books," that is, unemployed. As soon as there is a falling off in work the same tactics will no doubt be repeated. The aim of the Union as set forth in Clause 2, Rule 1, is no doubt a very good one. The unfortunate part of it is that unions do not as a rule aim very straight, and seldom hit the target which they profess to aim at. Our article was in no sense intended to be a hostile attack on any body of men, but was merely a statement of facts which have actually occurred, and will be corroborated by most engineers who have had the supervision of installation work for any considerable number of years.—Eds. Elec. Rev.]

The Lee-Coll Battery.

Will some one of your readers oblige me with the address of the makers of the "Lee-Coll" storage battery as described in the Review of November 16th last?

C. B. N.

Manchester, *March 12th*, 1900.

[The British and Foreign Electrical Vehicle Company Limited, 4, Bloomsbury Place, London, W.C.—Eds. Elec. Rev.]

Trolley Earthing Device.

I have noticed in one of our leading electrical journals an account of an earthing device for trolley wires in the event of telephone or other wires falling across the trolley wire, viz., a long bamboo rod or pole, hollow or solid, with an insulated wire for connecting trolley wire *direct* to *rails*, thus releasing automatic switch in the section pillar or station. To save the trouble of using bamboo rod, I suggest having a S.P. switch in a box fixed to side of stairway, or any suitable, convenient place at each end of car, to be operated by driver or conductor, connecting the trolley with the car body, thus putting trolley wire direct to rails as soon as switch is closed, so that in the event of wires falling, the driver or conductor could thus cut out the section or the whole trolley wire. All that is necessary for the public to do is to communicate with the first car they see; also places could be provided on the section feeder pillars, like those provided for fire alarms, viz., a S.P. switch in a case, with instructions to break glass and put switch in, thus putting trolley wire direct to rails. I shall be glad if you will consider this idea, as I think it solves the problem now before electrical engineers; three or four of these switches in every ½-mile length could be installed at a moderate cost.

An Electrician.

[This is certainly a simple suggestion, well worth consideration, and we have pleasure in placing it before tramway engineers. We do not suppose, however, that they will

favour the idea of providing means for irresponsible members of the public to earth the trolley wire.—Eds. Elec. Rev.]

BRITISH INSULATED WIRE COMPANY'S STAFF DINNER.

The B.I.W.'s staff dinner, which originally assumed comparatively small dimensions, has within the last year or two become quite an institution, and apart from the staff, there is now to be seen a very fair sprinkling of eminent electrical engineers among the guests who gather round the hospitable board of the B.I.W. Company.

On the occasion of the dinner this year a saloon carriage was attached to the 12.15 train from Euston for the special use of those who, at the invitation of the B.I.W., intended to travel from London to Liverpool, and it is needless to say that the arrangements for the comfort of their guests were upon the complete scale which is usually experienced in connection with arrangements made by the company.

The dinner itself was an unqualified success from a historic, musical, electrical, commercial and gastronomic point of view.

An excellent orchestra discoursed sweet music during the dinner, and subsequently vocal music by the Minster Vocal Quartette enlivened the intervals between the toasts and the responses thereto. To those who are cursed with musical intuition, it was somewhat painful to notice the very marked difference in the appreciation by the assembled company of Paderewski's Minuet in G, for instance, and of selections from the "Belle of New York." It would be invidious to make any suggestions as to the taste of the audience, but it may be just mentioned that while portions of the "Belle of New York" were accompanied by a sympathetic outburst on the part of many of the diners, Paderewski's minuet was entirely drowned by the clatter of plates, knives and forks.

The toast of "The King," given by Mr. W. Marriner Brigg, who presided, may be summed up in the French saying, "La Reine est morte, vive le Roi."

The Chairman called upon the Hon. Arthur Stanley to propose the next toast, remarking that the British Insulated Wire Company owed a deep debt of gratitude to the hon. gentleman.

The Hon. Arthur Stanley, M.P., proposed the toast of "The Electrical Industry." Speaking in a felicitous vein, the hon. gentleman said that it was characteristic of the industry that it had gone through much the same processes as the volunteers. First electricity was derided and then tolerated. In 1896 £61,000,000 was invested in electrical concerns, while in 1900 this had risen to £124,000,000. This spoke sufficiently well for the progress of electricity. Referring to the recent fall of electric wires in Liverpool, the hon. gentleman said that the accident only showed that authorities should give every facility to electrical engineers. If they knew that it was best for telephone wires to be underground where there were trolley wires, then they should be allowed to put them underground. Electrical engineers were experts, and as such they should have a free hand to carry out their business. Speaking of the position of the electrical industry, he thought that England would take her proper place at the head of the industry. That being so, the British Insulated Wire Company, who had been pioneers in the business, should succeed.

Mr. S. Z. de Ferranti responded. At previous gatherings he had, he said, foreshadowed the great development which there had been in the electrical industry. He was confident that in comparison with what there had been, future developments would be enormous. Fortunately, electrical work was looked upon in a more friendly manner than it was some time ago, and more facilities were being given for the distribution of greater electric power over small areas than was before given for the distribution of less power over greater areas. Great distribution over small areas was an important factor, and upon it would greatly depend the success of various undertakings. He looked forward to the comparatively speedy utilisation of electric energy on main lines of railways, if not on all railways. There were overwhelming advantages to be derived from the change.

Alderman T. Snape proposed the toast of "The Visitors," which was responded to by Mr. W. M. Mordey.

Mr. J. S. Raworth proposed "The British Insulated Wire Company," to which Mr. J. B. Atherton responded.

Mr. Atherton expressed very strong views upon the detrimental effect upon British trade of the Free Trade principles upheld by Great Britain. He cited chapter and verse for his contention that while in itself Free Trade was a good principle, the fact that Great Britain alone acted up to her convictions, placed British trade at a disadvantage in comparison with foreign competitors. It is evident that Mr. Atherton has thought deeply on this subject, and has firm convictions which would not be easy to shake, and there can be no doubt that from the B.I.W.'s point of view there is a great deal to be said for Mr. Atherton's contention.

However, the subject of Free Trade is one that admits of absolutely indefinite discussion, and it was, therefore, perhaps fortunate that there was no one down on the list to respond to Mr. Atherton!

The toasts of "The Directors of the British Insulated Wire Company," and "The Chairman," were also proposed and fitly honoured.

It is felt that before long someone will discover that Prescot is the Athertoniensis of the ancient Romans.

LEGAL.

Sotheby & Co. *v.* Minturn.

Mr. Justice Channell, sitting without a jury in the King's Bench Division on Thursday, heard this case, which was a claim for work and labour done, and material supplied. The work was the installation of electric light in a private house, and the amount was £51.

Mr. David appeared for the plaintiff, and Mr. Rose Innes for the defendant, Miss Minturn, of 14, Chelsea Embankment.

Mr. David said the defendant seemed to have employed a gentleman named Swinton to negotiate matters for her. She was an extremely punctilious lady, and insisted on an estimate for every item of a few shillings, and the work had to be done on terms agreed with her within 14 days. That was the original work, which came to £27. The very day that the plaintiffs' contractors went in they were stopped by the defendant, and the work was suspended in order to allow of an inspection of the premises by some other parties with whom she had got into litigation, especially in the decoration of the premises. There was at once a stoppage of the work, and afterwards alterations and additions to the contract, and the whole thing which commenced in February did not get finished till May. The lady kept asking estimates for very small items, and wished to impose penalty clauses, and so on, and things got to such a pitch, that on May 16th plaintiffs declined to do any more work. The defendant claimed £79 for liquidated damages by way of counterclaim, at the rate of £1 a day for the time over and above that stipulated for.

In the result, his Lordship gave judgment for the plaintiffs for £41 15s. 10d., and also for the plaintiffs on the defendant's counterclaim.

Lessing and Another *v.* The Electro-Chemical Company of St. Helens.

In the King's Bench Division of the High Court of Justice on Monday Mr. Justice Bigham, sitting without a jury, concluded the hearing of the case of Lessing and Another *v.* The Electro-Chemical Company, Limited (1900), of St. Helens, Lancashire.

Mr. Danckwerts, K.C., and Mr. Loehnis were counsel for plaintiffs, and Mr. Carver, K.C., and Mr. Spencer Bower for the defendant company.

Plaintiffs were Mrs. Bertha Lessing, widow of the late Dr. Lessing, an electrical inventor, and Mr. Kurt, of Nuremberg, Germany, and their claim was for £184 18s. 1d., the value of carbon plates supplied to defendants, who are manufacturers of and dealers in various chemicals and substances, in which they employ certain electrolytic processes. The contract, which was entered into in April, 1900, was for the supply of 12 tons of Lessing's carbon plates at £38 per ton, the plates to be 18 ins. by 5¾ ins. The defendants said that the plates were not delivered according to contract either as regarded quality or quantity, and defendants counterclaimed for damages for their works having been kept standing idle in consequence.

A considerable amount of expert electro-chemical evidence was called as to the quality of the carbon plates supplied, and after a lengthy hearing his lordship, in giving judgment, said he had come to the conclusion that his judgment must be for the defendant company. The plaintiffs' own witnesses admitted that the new kind of plates supplied by them were not as good as the old plates which had been supplied by the late Mr. Lessing. It was true that they qualified that admission by a statement that the difference was so slight that, in their opinion, one kind of plate was commercially as good as the other; but he could not endorse that qualification. He did not think that the tests which the plaintiffs had had made were really reliable tests, or made in relation to the circumstances under which the plates had been used. They were laboratory tests, and, he had no doubt, carefully made, but they were, in his opinion, not satisfactory. The defendants had, however, made practical tests, and had found a great difference in the life of the two kinds of plates, a most important matter. He had come to the conclusion that the plates—for what reason he did not know—whether because the present Mr. Lessing had not the skill that his father had or for some other reason—turned out to answer the contract sued upon were not in accordance with the contract, inasmuch as they were not equal or anything like equal in quality to the old plates which had been supplied in the late Dr. Lessing's lifetime. He regretted very much that over so small a matter these German gentlemen should have taken the trouble to come to this country to bring this action at great expense. He gave judgment for defendants on the claim, and dismissed the counterclaim without costs.

The Cuba Submarine Telegraph Company *v.* The West India and Panama Telegraph Company.

In the Court of Appeal on Tuesday, before Lords Justices Rigby, Vaughan Williams and Stirling, the hearing was commenced of this case on appeal by the defendants, from a decision of Mr. Justice Farwell. The case was one which raised questions as to the construction of an agreement dated January 31st, 1870, entered into between the plaintiffs and defendants. The plaintiffs are the owners of submarine telegraph cables laid along the south coast of the island of Cuba, and a landline across the western extremity of the island of Havana, the cables thus connecting Havana with Santiago. From Havana, submarine cables owned by the International Ocean Company ran northwards to Florida, which

was connected by a landline with New York. Defendants were the owners of submarine telegraph cables running from Santiago to Jamaica, and to nearly all West Indian islands, and to Georgetown and Colon, Panama. By the agreement in question between the plaintiffs and a company of the same name as the defendant company (being the predecessor of the defendant company) it was provided that:—"1. The Cuba Company will hand over to and forward by the West India Company all telegraph messages received by or sent through the lines of the Cuba Company for any other parts of the world with which the West India Company may be in telegraphic communication. 3. The West India Company will hand over to and forward by the Cuba Company all telegraphic messages received by or sent through the West India Company for such places as the Cuba Company may be in telegraphic communication with. 4. Each company party hereto will forward the traffic and messages received from the other company with all possible expedition, and in case of breakdown of line will repair the same as speedily as practicable, and generally will assist by every means in their power to develop the traffic and business of the other company. 5. Neither company party hereto will enter into any agreement of the traffic arrangement with any other company or persons, or be connected with or interested in any telegraphic line whatsoever, which may be prejudicial to the interests of the other company party hereto without the assent in writing under the seal of the company being had and obtained. But either company shall be at liberty to send messages over their lines at the written request of the sender of such messages without solicitation or suggestion by any competing lines, provided that in such case the other company party hereto shall share in the amount accruing in respect of such messages in proportion to the amount each company would have received had the messages gone over the lines of both companies. 7. The West India Company are to be at liberty to place all their wires and cables at Santiago de Cuba in connection with the wires and cables of the Cuba Company, and they are also to be at liberty by their own officers and servants to work all through traffic from any part of the West India system to any place or places beyond Havana without any interruption or interference by the Cuba Company, and the through traffic of the West India Company is to take precedence and have priority over all the local traffic of the Cuba Company, except as otherwise provided by the terms of the said concession. 8. The West India Company are to find supply and maintain the necessary staff at Santiago de Cuba for working, not only their own lines, but also the Cuba lines, charging the Cuba Company a fair proportion of the cost of staff at Santiago de Cuba, and the whole cost of staff at the intermediate station or stations, and an addition of 25 per cent. on such cost, their share of the expenses of general management and superintendence." The plaintiffs' case was that by means of defendants' cables they are in telegraphic communication with all places directly served by defendants' cables, and with places beyond with which defendants are in telegraphic communication, and further, that by means of the cables from Havana to Florida, and of the landlines to New York, and of submarine cables from New York across the Atlantic, all places directly served by defendants' cables, and places beyond with which defendants are in telegraphic communication, with North America and with London and other places in Europe. A new cable had recently been laid between Bermuda and Jamaica by the Direct West India Cable Company, and by such means and the cables of companies allied with the Direct Company, the plaintiffs' case was that competition with the business of the plaintiffs and the defendants was threatened. They (the plaintiffs) charged that any such arrangement as defendants threatened to make with the Direct Company, whereby messages handed in by the Direct Company at Jamaica would be transmitted by defendants' lines to places south and east of Jamaica at a rate lower than that charged locally from Jamaica to such places, would be an agreement or traffic arrangement prejudicial to the interests of the plaintiffs, and that any such arrangement would constitute a breach of Clause 5 of the agreement—plaintiffs accordingly claimed an injunction to restrain defendants from committing breach of Clause 5 of the agreement, and also an injunction restraining defendants from forwarding any telegraphic messages received by defendants to Jamaica from the Direct West India Cable Company for transmission to the east or south of Jamaica under an agreement or traffic arrangement which was, or might be prejudicial to the interests of the plaintiffs, and for consignential relief and damages. The defendants contend that they had never threatened or intended to do what the plaintiffs alleged, and further, that the plaintiffs had claimed to do, and had for many years done, and were still doing, the very thing which they now claimed defendants were not entitled to do. In 1889 a French company, La Société Francaise des Telegraphie Sous Marine, opened a system of cables between Santiago de Cuba, Porto Plata, San Dominique, Curaçoa, and Venezuela, and in 1890 opened cables between Martinique and Paramaribo. In 1891 they also laid a system of cables between Paramaribo, Cayenne, and Vizon, and between Porto Plata and Martinique, and the French company's lines therefore connected Santiago de Cuba (the eastern extremity of the plaintiffs' system) with Martinique, Paramaribo, Cayenne, and Vizon, and thus it became possible to send messages from and to New York and London over plaintiffs' system. Defendants, therefore, counterclaimed for an injunction restraining the plaintiffs from handing over to the French company at Santiago de Cuba any telegraphic messages sent over plaintiffs' lines for transmission to Cayenne or Vizon, or any place south of Martinique, except such messages as the sender thereof, without solicitation or suggestion, should in writing request plaintiffs to forward by way of the lines of the French company. By way of further relief, the defendants claimed an injunction restraining plaintiffs from entering into or continuing any agreement or traffic arrangement with the French company or any other company or persons which might be prejudicial to the interests of defendants without their assent in writing. Mr. Justice Farwell had held that the plaintiffs were entitled to succeed, and granted a declaration in the terms asked for, with costs.

Mr. Haldane, K.C., in opening the appeal, having indicated the routes of the different cable companies concerned in the action, said that going back to 1869, the important company in promoting telegraphic enterprise, was the International Company, which had a cable from Lake City to Havana, and was connected with New York by another line. At that time the only connection with the West Indies was that of the International to Havana. The International was an American Company which had obtained various concessions for cables in the West Indian islands, some from the Spanish Government, and some through the English Colonial Office, and if it did not actually promote, it took a great interest in the promotion of two companies, which it was intended should enter into an agreement with it. The first company contemplated was the defendant company, the West India and Panama Telegraph Company, and this company was got up for the purpose of continuing the telegraphic communication from Santiago to the West Indian Islands and to the mainland. That was carried out, but there was a temporary hitch in the scheme, which arose in this way: It was intended that the communication between Havana and Santiago should be by means of certain landlines which the Spanish Government had laid in Cuba, but Cuba, even then, was not a very comfortable place for telegraphic operators, and the wires were often found to be cut. Consequently it was found that the only way of putting the matter on a satisfactory basis was to lay the cable just outside the island of Cuba, touching at Cienfuegos, to Santiago. This was done, the result being that there was now a direct line of communication between Lake City and Havana and between Havana and Santiago. The memorandum of association of the West India Company stated, "The objects for which the company is established are the effecting of telegraphic communication between the Island of Cuba and the Continent of South America, Central America, and other parts of the world, either through the West Indian Islands or otherwise by laying and working submarine or other telegraphs for and to such extent as may be determined upon, and for entering into such contracts as may be necessary and expedient for any of the aforesaid purposes." He understood his learned friends to say that when the expression "telegraphic communication" was used in the agreement which was to be construed in this appeal it meant a question of rates—that the company was in telegraphic communication with any part of the world under the agreement if it could send messages to that part of the world at such rates as would make competition possible. In other words, in order to have telegraphic communication it was suggested that it was not necessary to lay the cables or to have control of the cables to a particular place, but that it was enough if they could get a message through at such a rate as would make competition possible between that and other companies. The defendants said, on the other hand, that in the agreement telegraphic communication meant having the cables, and they relied a great deal upon the words in the third article of association as showing the meaning. The words were effecting telegraphic communication, &c., by laying and working. He thought it reasonably clear that the telegraphic communication there referred to telegraphic communication by laying the cables.

Lord Justice Rigby: You say that telegraphic communication means laying the cables?

Mr. Haldane: Yes.

Lord Justice Williams: Are the words telegraphic communication in the agreement which we have to construe, or are they in an agreement which relates to the effecting of telegraphic communication?

Mr. Haldane said that was first one of the questions. They certainly did refer to something more, and that would be one of the questions which their Lordships would have to determine, whether they could limit telegraphic communication to the use of the cable of another company by making some arrangement or other. He next passed to the memorandum of association of the Cuba Company—a company which, in a very large measure, was an afterthought consequent upon the dangers attending the use of the existing landline in Cuba. The special functions of the company were to make telegraphic communication in Cuba, the objects set out in the memorandum of association being the "effecting of telegraphic communication between Havana, Santiago, and other places in the island of Cuba by making, laying, and working submarine and other telegraphic lines from and to such points as might be determined upon, with power to purchase existing lines or telegraphs, &c. On July 24th, 1869, there was an agreement between the International Company and the trustee for the West India Company, and six days later the last named company was incorporated. Then on January 21st, 1870, the Cuba Company was incorporated, and subsequently in the second year there was entered into the agreement which was the subject of this litigation, and which was made between the Cuba Company and the West India Company.

Lord Justice Williams: Until the formation of the Cuba Company it had been proposed that communication should be by means of the Spanish lines running through Cuba?

Mr. Haldane said that was so.

Continuing, Counsel said that in 1877 the West India Company was reconstructed, and on July 3rd, 1877, there was an agreement between them and the Cuba Company, adopting and making binding upon the new company the old agreement. Then in 1882 lines were laid by the Western Union Company, they becoming the first competing lines between New York and the West Indies.

Mr. Swinfen Eady, K.C., who appeared for the respondents, said he did not remember any evidence as to that.

Mr. Haldane remarked that nothing very much turned upon it.

But in any case the Western Union Company laid down lines which formed a sort of alternative route. It was the subsequent alternative route which caused all the trouble.

(To be continued.)

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Mar. 13th, 1900.		Week ending Mar. 12th, 1901.	
Amsterdam	Value £140	Adelaide	Value £445
Buenos Ayres. Teleg. mat.	495	Amsterdam	612
Calcutta	502	Antwerp	21
Cape Town	687	,, Teleph. mat.	130
Channel Islands	280	Auckland	95
Cologne	25	Bombay	40
Copenhagen	14	Brisbane. Teleg. mat.	24
Durban	140	Buenos Ayres. Teleg. cable, &c.	319
Gothenburg. Teleg. wire	20	Calcutta	2,286
Hamburg. Teleg. mat.	700	Cape Town	1,009
Karachi. Teleg. mat.	3,407	,, Teleg. mat.	14,449
Launceston	46	Colombo	212
Madras	49	,, Teleg. mat.	18
Malta	61	Durban	191
Melbourne. Teleg. wire	2,961	East London	31
Odessa	150	Hamburg. Teleg. mat.	200
Rio Janeiro. Teleg. mat.	236	Havre	190
Rotterdam. Teleg. mat.	200	Hong Kong	10
Shanghai	842	Liban	20
Singapore	13	Melbourne	3,526
Stockholm. Teleg. wire (105 tons)	—	Port Chalmers	105
Sydney	460	Port Elizabeth	86
Valparaiso	112	Shanghai	148
		Sydney	1,648
		Tientsin	21
		Vera Cruz	51
		Wellington	1,144
		Yokohama	578
Total	£10,987	Total	£27,604

Foreign Goods Transhipped.

Gothenburg. Teleph. apprts.	Value £89
Madras. Elec. cars.	170
Sydney. Elec. mat.	106
Trinidad. Elec. goods	88
Total	£353

Auction Sale.—Messrs. Percy Huddleston & Co. will on March 28th and 29th offer for sale in London the stock of an electric supply stores. See our advertisement pages for details.

Bankruptcy Proceedings.—At the Birmingham Court on 12th inst., a receiving order was made in the matter of Albert Isaac Greenberg, of Erdington, electrical engineer, carrying on business and trading as the Midland Electrical Company, at 20, Caroline Street, St. Paul's, Birmingham.

Dissolutions and Liquidations.—Creditors of the Electric Resistance and Heating Company are to send particulars of debts, &c., to W. Chaplin, Dashwood House, E.C., the liquidator, by April 19th.

A meeting of St. Stephen's Electrical Syndicate will be held on April 10th at 1, Arthur Street East, E.C., to hear an account of the liquidation proceedings from Mr. A. N. Tessier, liquidator.

Messrs. T. Fidge, G. Ryman, and E. H. Graesser, electrical, mechanical and cycle engineers, 41A, Ebury Street, W., and Croydon, have dissolved partnership. Mr. Fidge attends to debts, and will continue the business as Fidge & Co.

Messrs. L. Bristöl and T. Raaschou (electrical manufacturers and engineers, Bristol Electric Safety Lamp Works, 40, Great Smith Street, Westminster) have dissolved partnership. Mr. Bristöl continues the business under the old style, and will attend to debts.

The Morecambe Electric Launch and Power Syndicate is winding-up voluntarily, with Mr. J. Gibb, of 6, Skipton Street, Morecambe, as liquidator.

The Crowdus Accumulator Syndicate, Limited, meets on April 15th, at Westminster, to hear an account of the liquidation from Mr. Claud Scott, the liquidator.

The "Perfect" Arc Lamp and Accessories Company, Limited, meets at 86, Gracechurch Street, E.C., on April 18th, for a similar purpose. Mr. S. H. Lee, liquidator.

Catalogues and Lists.—We have received from the Electrical Company, Limited, a copy of their No. 17 list of alternating current electricity meters. The list, which is very fully illustrated, contains diagrams of connections and dimensions of meters for two or three-wire systems, for measuring currents up to 2,000 amperes. Prices and weights, reference numbers, &c., are stated in tabulated form. The small type alternating current watt-hour meter is fully described, as are also high tension meters for single-phase and two-phase currents. Toward the end of the list we find instructions for setting up and starting meters, particulars of apparatus for calibrating meters, and directions for using test terminals.

The Allgemeine Electricitäts Gesellschaft, of Berlin, sends us a copy of a beautifully illustrated brochure entitled "Centrale Schiffbauerdamm-Luisenstrasse der Berliner Electricitäts Werke."

A list of ejector condensers for electricity works has been issued by Messrs. Korting Bros., Westminster. The construction, cost and method of application are detailed, and dimensions, both in inches and in mm., are set out in table form. There are also some notes on spray cooling, accompanied by a photograph of such plant supplied to the Cheltenham Electricity Works, where a fourth repeat order is now being executed. The makers claim that the spray cooling is simpler and more effective than tower cooling arrangements, requires less power for working, and is lower in first cost. Spray cooling requires a larger area than cooling towers, but it is said that in many cases this is found to be only a slight disadvantage. We understand that during the last few years Messrs. Korting have fitted a number of ejector condensers at various electric lighting stations. Their condensers are dealing with over 10,000 H.P. at the Corporation stations in Manchester and in Liverpool. The large Musgrave units at the Corporation station at Manchester have Korting condensers, as have also the two new Ferranti 1,000-H.P. units. At Liverpool there are nine of these condensers, each for a Willans engine of 1,200 I.H.P. The satisfactory working of the condensers is said to be largely dependent on the suitable arrangement of pipe connections, &c.

Messrs. Gunther & Sons, of Oldham, send us a copy of the sixth edition of their turbine catalogue, which contains full descriptive particulars of the Girard turbines with vertical and horizontal shafts; also the Pelton wheel, the Jonval turbine, mixed flow turbine, turbine governors, and turbines for driving dynamos. These notes are accompanied by some excellent photographic illustrations, one showing the interior of the Oldham works, and others illustrating the different machines mentioned. There is some general information relating to the power, fall and measurement of water, followed by numerous references in table form, showing where their turbines are in use in electric light and power works and for a hundred other industrial purposes.

The Spiral Globe, Limited, sends us its new illustrated catalogue of spiral globe lamps. The list includes diagrams showing construction of the lamps and globes, also prices of same. We understand that the company has just introduced, and is preparing to place on the market, some further developments of the spiral principle in the shape of spiral mantles and opal spiralettes.

A copy of the latest edition of Messrs. Babcock & Wilcox's catalogue is before us. The title of the book, as usual, is "Steam: Its Generation and Use." In the course of 170 pages the advantages of water-tube boilers, and the Babcock & Wilcox in particular, are stated, together with particulars of construction, and descriptions of a number of steam plants equipped on this well-known system, these being accompanied by numerous illustrations. Several other small lists describe their superheaters, feed water purifiers, and other parts of steam equipment.

Messrs. Connolly Bros., Limited, of Manchester, have issued a supplementary price list of insulated wires and cables. The list cancels certain portions of No. 4 catalogue. Tables of reference give particulars of copper conductors, vulcanised rubber cables, lead-covered ditto, light insulation wires, also of jointing and other materials.

A new price list, March, 1901, of electric light cables and wires has been brought out by W. T. Henley's Telegraph Works Company, Limited. A convenient arrangement of tabulating the details of various cables and wires (insulated with vulcanised and unvulcanised india-rubber) is adopted, together with a thumb index for the different sections.

A copy of the Dermatine Company's new price list is before us. Therein we find a description of the collection of raw rubber and gutta-percha; the distinctive characteristics of Dermatine are pointed out. The special feature in the catalogue consists of maps showing the districts throughout the world where raw rubber is collected. Dermatine goods are particularised in the list, such as air-pump valves, hydraulic rings, hose, tubing, mats, &c.

From Messrs. J. Spencer, Limited, of Wednesbury, we have received several circulars of their high pressure steam mains, with solid welded flanges, for electric light and power stations, also a photograph of a quantity of taper telegraph poles.

The B.T.H. Company's March pamphlet, No. 89, describes their slow and moderate speed belt-driven generators. The "Thomson Recording Wattmeters" form the subject of pamphlet No. 86.

Distillery Lighting.—Mr. Maurice Pitman, of Dublin, has secured the contract for the electric lighting of the Irish Distillery, at Chapelizod, Co. Dublin, for the Distillers Company, of Edinburgh. The work includes a steam engine, switchboard, multipolar dynamos, shafting for enabling the dynamos to be driven either by water or steam, also the whole of the wiring.

Electric Ferry.—It has been suggested that an electric ferry boat shall be placed on the river Medway, at Snodland, near Rochester, to convey passengers from the Burham to the Snodland side of the river. There has been a great deal of talk about a bridge or sub-way, but that appears to have been dropped, and the electric ferry is the latest suggestion. There is a great deal of traffic just here, as the river separates large cement and paper manufacturing towns, and the only present means of access is by a rowing-boat ferry.

Electric Tricycles.—A novel application of the overhead conductor system is about to be made at the Friedenau cycle racing track in Berlin. A number of electric motor tandem bicycles are being acquired for pacing purposes, and instead of the electrical energy required being furnished by accumulators carried on the machines themselves, it will be taken from an overhead conductor the same as an electric tramway, which is to be erected round the track. Messrs. Siemens & Halske are reported to be interested in the scheme.

Electricity on Warships.—H.M.S. *Albemarle*, which was launched at Chatham Dockyard last week, has been fitted up with modern electrical appliances. She has four dynamos, each giving

480 amperes at 100 volts, two in the engine rooms, and two in the auxiliary machinery compartments aft. By an arrangement at the switchboard, any of the dynamos can be put on to any or all of the many circuits of the vessel. There are also six powerful search-lights, one on a platform high up on each mast, and two on each bridge. The after capstan is worked by an electric motor.

Embezzlement.—At the Clerkenwell Police Court on 6th inst. Francis Sims, a wire worker, of Camden Passage, Islington, was charged on a warrant with embezzling moneys received by him on behalf of the Electrical Trades Union, having premises at the Club Union Buildings, Clerkenwell Road. Mr. G. Temple Martin, who prosecuted, said Sims was empowered to receive contributions from branches of the Union in different parts of the country. In this case the defalcations amounted to about £80.

Certain evidence having been given, the accused was remanded.

The hearing was resumed on Tuesday.

Mr. Travers Humphreys, who prosecuted, said the prisoner had been the general secretary of the Union for four years. Evidence had been given of the receipt by the prisoner of sums of £20 and £216 9s. from Leeds. It was now proposed to further charge him with stealing two sums of £1 12s. and £4 5s., received from the Norwich branch of the Union, and a sum of £17 18s. 6d. received from the Blackburn branch of the Union. In April of last year there was a dispute in the electrical trades in Scotland, and the organising secretary of the Union (Mr. Ewer) was sent to Scotland to take part in it. Prisoner received sums from the general treasurer, which it was his duty to send then to Scotland to assist in carrying on the dispute. In March last year the prisoner received £20, but sent only £18. In April he received £10, and sent the whole of the money, but later the same month he received £14, but only sent £10 to Scotland. On May 31st he received £10 and sent £8. The defalcations were discovered after the prisoner had been dismissed from his office and was succeeded as general secretary by Mr. Ewer, who noticed that the receipts given by the prisoner for the sums he had received did not tally with the amounts he had sent to Scotland. The defalcations amounted in all to about £80.

The prisoner said he desired to plead guilty. He said he only received £2 weekly as general secretary, and for that sum he had "to carry the Union on his back" and work 80 hours a week. He received nothing for out-of-pocket expenses, and on a salary less than the Union demanded employers should pay their workmen, he was expected to travel about the country and spend money freely.

Mr. Chapman sent the prisoner to gaol for six months.

Imports of Foreign Electrical Plant.—A steady increase appears to be taking place in the imports for electrical goods and apparatus into this country. The value of such imports during February last amounted to no less than £97,296, which compares with £94,317 in the preceding month, and only £60,780 in February, 1900. For the two months ending with February last a total of £191,613 is shown, as against £123,933 in the first two months of last year.

Indian Barracks.—Messrs. Kilburn & Co. are to prepare for the Government of India a report on the installation of electric fans in the troop barracks in India.

New Copper Company in Glasgow.—There is an authoritative rumour about that a new company composed of local engineers is about to commence operations in Springburn or Clydebank districts. The work of the new concern will include electric light, telegraph and telephone cables and copper work of all descriptions, including tube work, for which latter there is a big demand in the local railway locomotive shops.

New Fire Alarm.—A novel thermostat has been devised by Mr. Musgrave Heaphy, which possesses a great advantage over the ordinary pattern, in that its condition may be tested at any time, and from any distance, in a most effective manner. The thermostat is of the mercurial type, with the addition of the testing device. While Mr. Heaphy is satisfied of the absolute reliability of the latter, he by no means considers that fire offices ought to reduce premiums where his invention is used.

Private Bills.—In the House of Commons on Monday the South Yorkshire Electric Power Bill was read a second time.

Prosecution of the Metropolitan E.S. Company.—On Saturday last the Metropolitan Electric Supply Company was charged on eight summonses charging them with having committed breaches of the West London Lighting Order of 1899 by laying down in the district more mains than had been sanctioned and approved by the late Marylebone Vestry, now the Marylebone Borough Council—viz., 44 mains instead of 29. Mr. Bodkin prosecuted, and Mr. Muir defended. Mr. Muir pleaded "Guilty" on behalf of the company to six of the summonses. According to the *Times* report, Mr. Bodkin explained that in May last the company were desirous of laying a number of low-tension mains for the transmission of energy from a distant station. They accordingly deposited a plan of the proposed works with the Vestry, and with one slight exception everything was agreed to. About the end of November it was discovered that the plans were being violated in several respects; the breaches were being made wider than they should be; the mains, instead of being laid under the footway, were carried into the carriageway, and in some cases more mains were being laid than had been sanctioned, and were being laid, not one on top of the other, as agreed upon, but side by side. The Council refused to sanction any deviation from the plan originally submitted. Mr. Muir urged that the works shown on the plan had not been deviated from in a single instance in which the public interest was concerned. The only offence for which they were summoned was for laying five extra mains, and this was done by the engineer under a mistaken idea of the rights of the company, in order to supply without delay a demand for a continuous current of electricity to the premises of two of their customers. The additional space thus occupied, however, was exceedingly small. Mr. Curtis Bennett said that he was of opinion that the plan submitted by the company was most misleading, and that nothing would have been heard of the extra mains but for the discovery made by the Council. The case was a bad one. He fined the defendants the full penalty of £10, with £5 5s. costs, on one summons, and £5, with £3 3s. costs, on each of the remaining five; £56 altogether. The other two summonses were withdrawn.

Sequestrations.—The estates of W. G. Higgs, electrical engineer, Percy Street, Glasgow, were sequestrated on March 2nd.

A meeting of the creditors of Francis Teague, electrical engineer, was held in the Globe Hotel, Paisley, on 8th inst.

Siam.—A Siam paper says that according to a Seoul despatch of the 12th inst., to the *Asahi*, the electric railway projected by Americans to connect Seoul and Kaijo has been sanctioned.

Commercial Intelligence says:—"A representative of the Westinghouse Electric and Manufacturing Company, Pittsburg, has been at Bangkok studying foreign business, and his company will no doubt secure its share in the supply of electric materials for the new tramways about to be built by the Siam Electric Company, Limited, Copenhagen, Denmark. About 10 miles of grooved rails will be required, and also rolling stock. A part of the machinery has already been ordered from the General Electric Company. The lighting plant, recently ordered by the company from Germany, and especially a large high-priced engine to operate the 400-KW. German dynamo, is said to be giving much trouble. There are some 123 miles of railway being built by the Siamese Government at present, which require bridge materials, rails, and equipment."

Stalybridge.—Crowther & Co.'s Electrical Industries, Limited, have obtained the contract for the electric light installation for Stalybridge Post Office.

Trade Announcements.—The Westminster Engineering Company, Limited, notifies that on March 12th next their head office and works will be removed to Victoria Road, Willesden Junction, N.W. Their branch office at 16, Davies Street, Berkeley Square, W., will continue as at present. The new works are considerably larger, and more convenient than the old ones.

Messrs. H. Schomburg & Söhne, of Berlin, informs us that the arrangement existing between themselves and Messrs. Witting Bros., Limited, London, as their sole agents for Great Britain, Ireland and the Colonies, was terminated by mutual consent on February 28th. Mr. Schomburg will be in this country during the month, and in the meantime orders should be sent direct to the Berlin office or reserved until his arrival.

Messrs. Woods & Co., of 2, Gray's Inn Road, notify that the name of the firm will be changed to Marshall & Woods, the partners being Mr. Alfred W. Marshall, M.I.Mech.E., A.M.I.E.E., who has been for the past six years electrical engineer and manager of the electrical department of the Crypto Works Company, Limited, Clerkenwell, and Mr. Maurice W. Woods, sole proprietor of Woods & Co., and partner in the late firm of Miller & Woods. The electric lighting business will be continued as before, and special attention will be paid to electric driving. The offices and showroom will remain at 2, Gray's Inn Road, but the workshop has been removed to the new factory at Shepherd's Bush, adjoining the terminus station of the Central London Electric Railway, where a plant of English and American tools of the latest pattern has been established. Electro-medical apparatus will continue to be made a speciality; also a special line of high-class small power electric motors and dynamos from Mr. Marshall's latest designs, and a line of small power gas engines.

The Reason Manufacturing Company, Limited, is removing its offices and works to more commodious premises, situated in Lewes Road, Brighton.

The business of Pritchetts & Gold has been converted into a limited company with the title "Pritchetts & Gold, Limited."

Mr. R. S. Blackburn, "consulting and contracting electrical engineer," has removed to Ribstone Works, Hebden Bridge.

ELECTRIC LIGHT AND POWER NOTES.

Aberdeen.—The electric light was totally suspended for a short time on Monday, the 11th inst., for the first time since the starting of the works in 1894. The failure of supply was due to the racing of a 420-KW. set, which was still in the hands of the contractors, who were then adjusting the governors preparatory to the official test, which was arranged for Wednesday. This racing caused a break in the steam pipe connections, which necessitated steam being shut off at the boilers, thereby cutting off supply. According to the recording instruments the lighting of the town was affected for 45 minutes, and the electrical tramcars were stopped for 23 minutes. The lighting was off this length of time owing to the fact that upon starting up on the town at nearly maximum load the armature of one of the sets was burned out.

The T.C. has agreed to apply to the Secretary for Scotland for power to borrow the further sum of £81,000 to meet the additional expenditure on machinery, buildings, &c., for the electricity works.

Brighton.—The borough surveyor last week reported to the Lighting Committee that, in accordance with instructions, he had prepared plans for the new tramway power station in Bread Street. He submitted the plans, and estimated the cost of the work at about £15,000. The Committee approved the plans and instructed the surveyor to prepare detail plans and specification for the performance of the work by special contract.

The Lighting Committee submitted tenders they had received for a supply of arc lamps, as follows:—

Brockie-Pell Arc Lamp Company, Limited	£1,753 7 6
New Century Arc Lamp Company	2,042 16 0
Gilbert Arc Lamp Company, Limited	2,080 17 6
Crompton & Co., Limited	2,240 0 0
Oliver & Co.	2,248 13 0
British Schuckert Electric Company	2,290 0 0
P. R. Jackson & Co., Limited	2,374 0 0

Tenders were also received from Messrs. Verity, Johnson and Phillips, &c., but these firms not having sent in a sample lamp within the time stated in the specifications, the tenders were not entertained. The Committee recommended that the tender of the Brockie-Pell Arc Lamp Company, Limited, to supply 115 double-carbon arc lamps, and to fix 107 of such lamps on standards erected by the Corporation, and to perform all other work in connection therewith in accordance with the specifications for £1,753 7s. 6d., be accepted.

Bury St. Edmunds.—The T.C. has decided to retain £1,332 (1 per cent. per week for 22 weeks on the contract price, £5,793) from the contractors, Messrs. Fowler & Co., Limited, on account of delay in delivery.

Canada.—Negotiations have been taking place at St. Catharines for consolidating the electric generating establishments in the city, and placing them in the control of the Cataract Power Company, of Hamilton.

Chatham.—The Sub-committee appointed to inquire into the question of the purchase of so much of the undertaking of the Chatham, Rochester and District Electric Lighting Company, Limited, as is within the borough of Chatham, have reported to a Committee of the Chatham Corporation that they have had an interview with Mr. E. Manville, as to his report on the undertaking, and they have instructed the town clerk to make a provisional offer to purchase the undertaking for £20,000. It was recommended that the action of the Committee be approved. It will be remembered that the Gillingham District Council have decided to act similarly as regards the New Brompton section of the company's works, and negotiations are pending with reference to a like matter in Rochester.

Colne.—The T.C. has received permission from the L.G.B. to borrow £33,729 for electric lighting purposes.

Darlington.—On Monday evening the electric arc lamps in the main streets were switched on by the Mayoress. Forty lamps have been erected by Messrs. Crompton & Co.; the pillars were made by Messrs. Mackenzie Bros., Edinburgh, and the mains laid by Callender's, to Prof. Kennedy's specifications.

Failsworth.—The D.C. has appointed Mr. C. F. Parkinson, of Morecambe, to advise on the question of the supply of electrical energy in the district.

Finchley.—Mr. J. Swinburne, who has been instructed to report on the electric lighting of the district, will submit his report to the D.C. by the 18th inst.

Glasgow.—The Lighting Department have consented to substitute incandescent lamps for the arc lamps in St. Andrew's Hall.

Hamilton.—The T.C. intends to apply to the Secretary for Scotland for leave to borrow £40,000 for electric lighting purposes.

Harrogate.—The T.C. has received sanction from the L.G.B. to the borrowing of the sum of £10,000 for electric lighting purposes.

Hendon.—The U.D.C. has decided to accept the tenders which were set out in our issue of 1st inst., but it is approaching the B. of T. with a view of obtaining an extension of time for carrying out the work for a period of three years. The D.C. has not yet obtained a site for the generating station.

Hornsey.—The D.C. has received permission from the L.G.B. to borrow £73,500 for electric lighting purposes.

India.—It is stated that the Government of India will shortly take into consideration a proposal for the introduction of electric power punkahs on the Eastern Bengal State Railway.

Johannesburg.—The borough electrical engineer has drawn up an extensive scheme and estimate for extending the distribution network for both public and private lighting. It is recommended that the capacity of the station be increased to 1,080 KW. by the addition of plant of 720 KW. The station expenditure will be £50,801; the cost of distribution works, £27,097; further feeders and distributors, £9,647; public lighting (including new arcs and conversion of 146 oil lamps for electric incandescents), £13,396—total £100,941. It is stated to be practically certain that the whole of the work will come to this country for execution.

Kirkcaldy.—Satisfactory progress is reported in connection with the electric lighting and tramway schemes. The engineers, Messrs. Kennedy & Jenkin, estimate the cost of the electric light and power scheme at £50,000, and the Committee recommend the Town Council to apply for borrowing powers for that amount; while the tramways, which will run from Links, *vid* High Street, to Oswald Road, Sinclair Town, a distance of three miles, are estimated to cost £37,000. The profit in connection with the electric lighting and power scheme is estimated at £544 per annum. A site for a generating station has been secured on the new road.

London.—WANDSWORTH.—A Post Office employé, while laying telephone wires in Clarence Street last week, accidentally earthed an electric lighting cable and received a sharp shock. The earth being sodden with rain, a wide area was affected, and (says the *Surrey Comet*) pedestrians in the street were startled to see the horses attached to passing vehicles suddenly begin to prance about, and step out with an action suggestive of three-year-old thoroughbreds. A donkey drawing a piano-organ seemed to thoroughly enjoy the shock, for it stopped right over the galvanised spot, and disconcerted the swarthy Tuscan in charge by indulging in a vigorous "cellar-flap" dance. Of course there was a dog in the case, and with true canine instinct it went sniffing around until it came in contact with an iron post, when, with an agonised yelp, it bounded high into the air.

STEPNEY.—The Finance Committee of the Borough Council, after consultation with Mr. Arthur Wright, has reported to the Council on the extensions of mains, street lighting, &c., in Mile End, Limehouse and St. George's, recommending that the sanction of the L.C.C. be obtained to a loan of £122,200. Mr. Wright in his report estimates that the outlay on buildings will be £8,582; on machinery, £12,100; on mains, £68,106; arc and incandescent lamps, £16,687. About 100 miles of cable, 20 miles of street trenching, and 280 arc lamps will be required.

Lowestoft.—The T.C., after considering Mr. Hawtayne's report, has decided to greatly extend the street lighting.

Manchester.—At a meeting of the City Council last week Dr. Bishop, chairman of the Electricity Committee, made a statement with regard to the supply of energy for electric lighting. It was supposed that the Committee were deliberately withholding such supply with the idea of using the energy for tramway purposes; they had at the present moment sufficient power to take on a considerable number of consumers for lighting purposes, but if they were to do so they might find when the heavy load came on in October that they would have to disconnect them. In four or five weeks they hoped to be able to know their position. The difficulty now being experienced was no new thing.

Mexborough.—The L.G.B. has consented to the U.D.C's. application for leave to borrow £18,000 for an electric lighting installation and refuse destructor.

Middlesbrough.—The E.L. Committee has decided to apply to the L.G.B. for sanction to borrow £21,000 for additional generating plant and extensions to mains.

Nelson.—The D.C. has appointed Messrs. Gibbings and Baker as consulting engineers for the new electricity works, and has decided to appoint a resident electrical engineer at £300 per annum.

Newcastle-under-Lyne.—Messrs. Lacey, Clirehugh and Sillar are to prepare a report on the electric lighting of the district for the Council.

Newport.—The new electric power station at Newport is estimated to cost £200,000. The original estimate was £130,000, and the increase is due to a determination to keep out the South Wales Electrical Supply Company. The installation will consist of three engines, developing 500 KW. each, one of which will be employed to run the cars, one to supply power to private consumers, whilst the third will act as a reserve for either power or cars as required. It is proposed to put 36 cars on the line, and it is intended to work them up to the B. of T. limit of 10 miles an hour. The buildings are designed to occupy about an acre and a third of land purchased from Lord Tredegar at a site on Corporation Road. It has been deemed advisable to have separate tenders for the foundations and for the superstructure. The tenders for the foundations, &c., are to be in by March 25th.

Plymouth.—The salary of Mr. Okell, who is promoted to be Mr. Rider's successor, will be at once increased from £200 (which he has been receiving as assistant engineer) to £350, rising by £50 per annum up to £500. Mr. Allen, who was promoted to Mr. Okell's post, will begin at £200, and rise to £300.

Portsmouth.—Large extensions of the electricity works and mains are foreshadowed in the report of Mr. Price, superintendent of the electricity works, recently presented to the T.C.

Keighley.—The new electricity works will probably be ready to supply electricity by Easter, nine months after the commencement of building operations. The site of the works was

formerly that of the gasworks, a somewhat singular coincidence. The loan granted was for £34,600. The works comprise offices, testing and showrooms; accumulator house containing a battery of 256 cells; engine house, in which two vertical high speed compound engines, each of 250 H.P. (by Messrs. Allen, of Bedford), have already been erected; and a boiler house equipped with two Lancashire boilers, by Messrs. Clayton, of Leeds. There is room in the boiler house for six boilers, and in the engine house for six engines. The boiler house is close to the G.N. goods yard, and a siding can be constructed at comparative little expenditure; water for condensing purposes is obtained from the river Worth. The mains are arranged on the "three-wire" system, and the pressure of distribution will be 250 volts. The Corporation has recently purchased the tramways, and dynamos have been procured capable of being used for lighting or tramway work; they and the switchboards were supplied by Messrs. Parker, of Wolverhampton. Already there are about 80 applicants for light and power.

Salford.—The T.C. last week came to a decision with regard to Councillor Haworth's dealings with a firm which was supplying machinery to the Electrical Committee; the report of the Committee that he and others had "shown a lack of scrupulous regard for their obligations as members of the Council," was carried.

St. Helens.—The minutes adopted at the last Council meeting showed that the town clerk had been instructed to apply to the Board of Trade for their sanction to the Corporation supplying electric energy for lighting purposes at 500 volts pressure, in cases where lighting mains are not available for the purpose. Resolved further, and subject to such sanction being given, that where lighting mains are not available for the purpose, consumers of electricity at 500 volts pressure for power purposes be permitted to use the current at the same pressure, and at the same price per unit, for lighting; provided that in no case shall the maximum demand for lighting exceed 4 per cent. of the maximum demand for power purposes. The report of the borough electrical engineer showed as follows:—Lamps connected to January 31st, 20,265, against 12,072 to the corresponding month last year; units sold for lighting purposes during January, 32,220, against 23,591; units sold for tramway purposes during January, 62,353, against 22,870; units sold for motors during January, 10,042, against 8,601. Mr. Highfield further submitted a chart showing the increase in the consumption of electricity for lighting, tramway, and power purposes respectively, since the opening of the works at Warrington Old Road.

South Wales.—The South Wales Electrical Power Distribution Company has at length reached the position of active operations; offices have been taken at Cardiff, and the directors held their first meeting on Monday in the Welsh metropolis. The raising of capital has not involved any difficulty, all the money required at present having been already subscribed. The first generating station will be set up at Treforest; the Rhondda, Aberdare, and Merthyr Valleys, as well as Cardiff, Barry, and Newport, are easily accessible from Treforest, whence the electric mains will run beside the railways.

South Yorkshire Electric Power Scheme.—The Bill was before the Standing Committee of the House of Lords on Monday, and compliance with the Standing Orders was dispensed with on condition that the proposed exemption from Section 81 of the Electric Lighting (Clauses) Act, 1899, should be struck out.

Stockton.—So popular has the electric light become that the Corporation now find it necessary to lay down additional plant. The extension of the mains to the neighbouring village of Eaglescliffe is nearly completed, and a large number of applications are coming to hand every week. The manager, Mr. W. Ford, has submitted to the T.C. an estimate for additional machinery and cables considered necessary, amounting to £21,000, which includes two boilers, mechanical stokers for five boilers, two 300-KW. steam dynamos, condensing plant, extensions of switchboard and cables, &c.

Sudbury.—A crowded meeting of ratepayers on Monday passed a unanimous resolution opposing the T.C.'s proposal to carry out an electric lighting scheme. As the result of this resolution and a similar one passed last week, the T.C. has decided to withdraw the application for a loan, and to negotiate with a private company for the transfer of the provisional order.

Ventnor.—An accident occurred at the Electric Light Company's works last week, cutting off the current to the consumers. Temporary repairs were effected, enabling the current to be supplied for public and private lighting the same evening to practically the whole of the town.

Wallasey.—At a monthly meeting of the D.C. last week, Mr. Richard Steel, Chairman of the Finance Committee, when reviewing the operations of the committee during the year, remarked that the Electricity Committee had done very well, for they produced a profit of £945 against an anticipated profit of £72.

Walsall.—The accounts of the Electrical Department for 1900 show that the amount already borrowed is £25,450, and there is power to borrow a further sum of £20,049, the greater part of which will be required for the extensions now in progress. The amount actually expended on capital account was £34,309, of which £1,500 had already been repaid. The total expenditure on revenue account for the past year was £3,100, and the receipts had been £4,693, leaving a balance of £1,593. After paying interest, &c., there remained a surplus for the year of £119. There had been each year a gradually decreasing deficiency, of which £275 still remains to be cleared off. The total production was 404,682 units, of which 111,433 was unaccounted for. The number of public lamps supplied was 19, and the maximum demand 301 KW.

Worcester.—The Corporation electricity accounts show a surplus for the year of £3 7s. 8d. Mr. Sutherland, electrical engineer, thinks it a matter for congratulation that the financial result shows a profit in spite of an increase in the coal bill of £1,051 8s., which was almost entirely due to the higher price of coal. If it had not been for this a profit of several hundred pounds would have been made. The total capital expended is £82,630. The amount paid for sinking fund and interest was £3,666, equal to 4½ per cent. on the capital expended. The increased annual cost by reason of having established works at Powick (three miles from the city) for the sake of water power, was said to be about £1,100, but Mr. Caldicott, a champion of the water-power works, pointed out that coal, by which half of the electricity had been generated, had cost £2,677 12s. 1d. The water power had produced an equal amount; therefore the difference between £2,677 and £1,100 represented a clear profit by water generation. This question of the wisdom of establishing water-power works so far from the city remains a matter of the keenest contention, though the works were established so long ago as 1894.

Yorkshire Electric Power Scheme.—At Huddersfield on Tuesday a meeting of representatives of urban district councils in the neighbourhood was held to consider the scheme of the South Yorkshire Electric Power Supply Company. Details were laid before the meeting by Mr. S. V. Clirehugh and Mr. W. E. Rowcliffe, and it was stated that the company would be prepared to insert in their bill a provision for compensation for damage to property through the company's operations, &c.

ELECTRIC TRACTION NOTES.

Barrow.—At the last meeting of the T.C., the Highways Committee recommended that the tramway system be not purchased from the British Electric Traction Company, but they were willing to confer with that company on certain terms as to tenure and conversion to electricity. The report was adopted.

Berehaven.—An application to the Board of Trade, under the General Pier and Harbour Act, has been made by the Irish Electric Railways Company, Limited, who apply for powers to levy rates and borrow £100,000, the estimated cost of constructing a conservancy and pier at Berehaven. No objection to the application has been made. The Board are in communication with the Lord-Lieutenant of Ireland and the Lords Commissioners of the Admiralty with regard to the matter, and in accordance with a request from the latter, the consideration of the order is for the present deferred.

Bradford.—In view of the impending lapsing of the leases on the old Bradford tramways, the Corporation Committee has decided to send a Sub-committee to visit the works of the principal car builders of the country and the towns in which electric tramways are at work, in order to obtain information as to various types of cars. Another Sub-committee has been appointed to consider and report whether the Corporation should themselves provide and erect the overhead equipment for the lines in question, or should have the work executed by a contractor. It has been determined that on one section—the Manchester Road route—the girder rail shall be used instead of the Demerbe. The Council decided that in future 5 per cent. of the net profits of the new electric tramways shall be set aside annually as an insurance fund against accidents.

Carnarvon.—At a meeting of the T.C. last week a letter was read from Mr. Peterson (into whose application for a prov. order to light the town with electricity a Board of Trade inquiry was recently held), to the effect that if the Corporation would make good their representations that they were the road authority of the land over which the proposed light railway line would run, and would give their assent and support his claim, he would undertake to make the application to the Light Railway Commissioners as soon as possible after the electric lighting order had been assured to him.

Crewe.—The Light Railways Commissioners have refused to give the T.C. an order for the construction of electric tramways within the borough.

Darlington.—The General Purposes Committee recommended that the negotiations be continued with the Imperial Tramways Company for the purchase of the present tramways, and that if terms could be arranged they be authorised to enter into a contract for the purchase of the property, including the transfer of the provisional order of the Light Railway Commissioners, for the sum of £7,500.

Dewsbury.—It is stated that the British Electric Traction Company intend to proceed with their scheme for the construction of electric tramways throughout the district almost immediately. Officials are now in Dewsbury making preliminary arrangements.

Dundee.—Mr. A. P. Trotter, of the Board of Trade, conducted the official inspection on 6th inst. of the electric equipment of the new east end route and of the Perth Road extension of Dundee Corporation Tramways.

Farnworth.—The U.D.C. has instructed Messrs. Lacey, Clirehugh & Sillar to prepare specifications for their tramway extensions, which consist of about five miles.

Gateshead.—The Parliamentary Committee has been considering the question of preventing accidents from telephone and trolley wires as at Liverpool. The Committee drew the Tramway Company's attention to Mr. Quin's device, but the company says that it has adopted another system which is claimed to be perfectly efficient. The company's electrical expert is to be asked to attend before the Committee and explain the device.

Glasgow Tramways.—Mr. Parshall states that a considerable section of the new electric tramway system will be in full working order by the end of April. The sub-stations at Partick and Whitevale are now complete, and the remaining three are nearing completion, while the main generating station at Pinkston is rapidly finishing. During the last 10 years up to May 31st last, £340,000 was spent in renewals and repairs of the lines. The contract for 1½ miles double line of steel rails has just been placed in America for extensions on Great Western Road. Where the trams extend into the country roads, the Council have decided to adopt the side-pole system for the support of overhead wires.

Halifax.—At a meeting of the T.C. on March 6th it was unanimously resolved that the recommendation of the borough electrical engineer, Mr. H. F. Street, be adopted, that after March 31st next the price of current to the Tramways Committee be raised from 1¼d. to 2½d. per unit, it having been shown that after paying interest and sinking fund charges and setting aside a proper amount for depreciation on plant and mains, a lower charge could not profitably be made. The estimate was based on a works cost of under 1d. per unit, the estimated output being 1,500,000 units. The Electricity Committee have already spent over £60,000 on plant, mains and buildings for tramway purposes alone. Mr. Street has been instructed to present a report *re* the recent accidents due to overhead electric trolley lines. He has been instructed to obtain tenders for a small motor-generator, which will be used for moving cars about in the car sheds after the outside lines have been shut down for the night. It will be driven off the direct current lighting mains.

Hull.—The Watch Committee has decided to purchase india-rubber gloves for the use of the police on point duty, so that they may handle without fear of injury any telephone or telegraph wires that may fall across the electric trolley wires.

Lincoln.—The City Council has decided to accept tenders for two additional panels for switchboards and for extensions of the engine and boiler house, and engine and boiler beds and flues in connection with the Municipal Electricity Works in Brayford Wharf. A conference has been held with the directors of the Lincoln Tramways Company regarding the conversion of the tramway now carried on by horse traction into an electric overhead system, but the result of the conference was not divulged. It is understood that as the Tramways Company's Bill allows them to continue running horse trams for some time yet, the Electricity Committee will not intervene until that time has expired.

Liverpool.—At the Tramways' Committee meeting held on March 8th the receipts for the past fortnight were reported to be £15,416, against £13,963 in the corresponding fortnight last year, an increase of £1,453. The mileage run during the fortnight was 389,471 miles, against 331,078 during the same period last year, an increase of 58,393. The number of passengers carried was 3,340,241, an increase of 670,577 upon the number in the same weeks of last year. There were only 17 horse vehicles at work, compared with 190 at the same time last year, and 265 electric cars against 106, an increase of 159.

In the Liverpool Court of Passage last week Philip McGurn claimed damages from Messrs. Blackwell & Co., Limited, for the loss of his son, Christopher McGurn, who died from injuries received by the falling of some overhead electric plant during the construction of the Corporation tramway lines in Robson Street in August last. The defendants undertook to pay plaintiff £55 as damages, with taxed costs. The case was therefore closed.

Middlesbrough.—A start has been made with the extension of the Linthorpe and Middlesbrough Exchange tram line to the Port Clarence Ferry, Mr. J. Clifton Robinson, managing director, personally superintending the commencement of the removal of the old line. The work is to be completed by May 1st.

Middleton (Manchester).—There was no opposition at a Government Inquiry held last week regarding the T.C.'s application to borrow £5,000 for road improvements for the tramway schemes in the borough. The Board of Trade required the roads to be widened before the tramways could be opened to traffic, hence the application.

Merthyr.—The Merthyr electric line was on Tuesday inspected by an official of the Board of Trade.

North Shields.—The electric tram system will commence operations very shortly between the New Quay, North Shields, and the boundary at Whitley. The Board of Trade inspection has been completed, and the report is awaited, and immediately on receipt of the necessary certificate the public service will commence. The total cost which the British Electric Traction Company have incurred for the reconstruction of the old line, the laying of the new, and the electrical equipment, is £58,000.

Oldham.—At last week's Council meeting Alderman Eckersley stated that the electrical equipment of the other sections of the tramways was being pushed on with as expeditiously as possible. He had been in communication with Messrs. W. T. Glover & Co., who were to supply the equipment, and they stated that the whole of the work on the respective sections would be completed within three months of starting.

Royton.—The D.C. is one of the authorities through whose district the Bury, Rochdale, and Oldham Steam Tramway Company had powers, and the Council is taking action with the other local Councils concerned with a view to purchasing the lines. The Oldham T.C. is endeavouring to have inserted into the Royton Electric Power Bill a clause preventing the Royton D.C. from entering into an agreement with the Tramway Company or with any other concern of that kind which the Oldham Corporation would not approve.

St. Helens.—The Electricity Committee has instructed the town clerk to write to the Tramways Company requesting them to provide a pair of rubber gloves for each car for use in the event of any of the wires falling. The borough electrical engineer was instructed to draw up and submit to the committee short instructions to be issued to the public as to the best steps to be taken in the event of any wires falling.

On Monday several members of the St. Helens Town Council witnessed a series of trials of a new life-guard which is being used for the electric cars on the St. Helens system. The tests were made on the length of new line in Corporation Street.

Sheffield.—Mr. A. L. C. Fell, in his monthly report to the Corporation regarding the tramways, states that he has made numerous tests of the guard wires in various parts of the city, and has ascertained that they are efficiently connected to the rails, so that in the event of a telephone or telegraph wire dropping and making connection between the guard wire and the trolley wire, the current will be put directly to the rails through the guard wire, and cause the circuit-breakers to immediately act and cut off the current at the power station. These tests have been repeated in the presence of the Board of Trade, Post Office, and telephone company's officials, and have been quite satisfactory. On February 27th one of the telegraph wires crossing the trolley wires near the Attercliffe Board Schools was dropped in the presence of Mr. Comport, chief engineer of the General Post Office for the district. The guard wire in the first place kept the telegraph wire entirely off the trolley wires, and the ends simply hung down to the street. The end of the telegraph wire was then carried across the road, and connection was made between the trolley wire and the guard wire. The telegraph wire was immediately fused off short near the trolley wires, and the current at the power station was automatically cut off at the same instant.

The chairman of the Gas Company (Sir Frederick Mappin) said a good deal to his shareholders about the electrolytic effect of tramway currents upon gas mains. He said that if the danger was as great as *some* scientific men believed it to be, "the Board of Trade or Parliament would of necessity be compelled to protect them and the public."

Underground Electric Railways.—The promoters of the Charing Cross, Euston and Hampstead Railway are approaching the Hampstead Borough Council with a view of securing the withdrawal of their opposition to the scheme. They promise that no portion of the railway should go under Hampstead Heath, and that no station should be erected either at North end or at the summit of the Heath. As it was on the above grounds that those interested in the preservation of the Heath opposed the railway, the promoters hope that the B.C. will not oppose the scheme. The Council have appointed a committee to meet the promoters and discuss the details.

The House of Commons on 7th inst. agreed to the resolution passed by the House of Lords, and printed in our last issue.

Warrington.—At the last T.C. meeting a resolution which appeared in the minutes of the Tramways Committee, that Messrs. Preece & Cardew be instructed to obtain tenders for the construction of the tramway from Sankey Bridges to Knutsford Road, gave rise to some discussion. Councillor Bennett contended that the overhead system, which it was intended to adopt, was unsightly and dangerous, and moved, as an amendment, that further consideration should be given to the subject before they committed themselves to anything. Alderman Monks stated that the system it was proposed to adopt was approved by the Council 12 months ago. The Telephone Company had entered into an agreement with the Corporation to place their wires underground, and he understood the Government were going to place the telegraph wires underground. The matter was urgent, as in their Tramways Order they had two years in which to complete the work. On a vote being taken only five voted for the amendment. The minutes were therefore confirmed.

(*Continued on page* 461.)

ELECTRIC CAR BUILDING IN ENGLAND.

(Concluded from page 416.)

Thus far we have followed the treatment of the timber from its arrival in the rough state, observing its dissection, shaping, and subsequent fitting together in the cabinet shop, where the larger parts are prepared ready for being built up into cars. In the picture of the cabinet shop which appeared last week, doors will be seen on the left through which these parts are taken straight into the car shed, one end of which, with cars in skeleton form, is illustrated in fig. 9. But before we trace the construction further, it is necessary to glance at the departments in which the iron and steel sections are prepared. The smithy (fig. 10) is furnished with half a dozen steam hammers of various sizes. Single, double, and quadruple hearths are employed. This department does not call for much attention at our hands, but it is interesting to mention that it comes under the domination of the exhaust system by which all sparks and noxious fumes from the fires, &c., are drawn underneath the shop, and thence out into the open air.

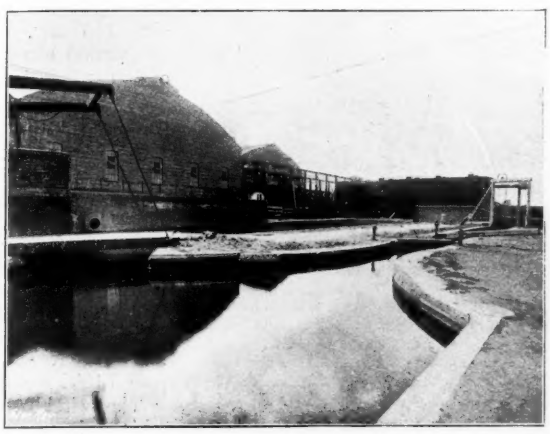


Fig. 8.—Canal and Private Dock.

We now come to the iron-working machine shop where the ironwork for the car is made ready for the fitter. A view of a portion of the shop is given in fig. 11. All the machine tools are electrically driven, and they comprise American-made lathes, drilling, planing, sharpening, and other tools of up-to-date construction. The motors driving the overhead shafting, &c., operating these, are 10-h.p. size running at 600 revolutions per minute, and they are of the same type as those employed in the mill and woodworking depôts. When the machines have performed the necessary operations and the metal portions of the car have been produced, these parts are at once transferred to the next department for finishing and fitting together as the underframe work of the car.

In the assembling room, which is practically under the same roof as the machine shop, the iron, steel, and wooden sections upon which the superstructure of the car is built, are gathered together, finished and fitted. Fig. 12 is a view of a portion of this room, showing a 10-h.p. motor driving shafting, with which are connected several grindstones and other machines, including the bending machine illustrated in fig. 13. There are a number of hydraulic presses and rolls for levelling and bending steel sheets, as well as a few machines for bending bar iron.

A number of underframes were in various stages of completion at the time of our visit. Subsequently the entire framework is in the ordinary way dispatched to the car building shed, where the final processes of construction are carried out, but, as has been already mentioned, the overcrowded state of the car shed has necessitated certain car building operations being carried on in the assembling room until the new shed is ready.

The operations in the car building shed are somewhat as follows:—The underframe as it comes from the assembling room is first laid down, and the upper skeleton of the car is fixed upon it ready to be panelled and framed. While the latter process is being carried on outside, the finishers are inside bringing the interior into shape. The fitters next apply themselves to the construction of the dash plates, staircase ladders, and top railings, and when these have been adjusted the car is handed over to the painter, glazier, and upholsterer for them to do their beautifying work. Many of our readers will probably be surprised to learn that as many as 20 coats of paint are frequently given to a car before it leaves Hadley. There are pits in the shed in order to facilitate the fitting of the underneath gearing, such as the brake, &c.

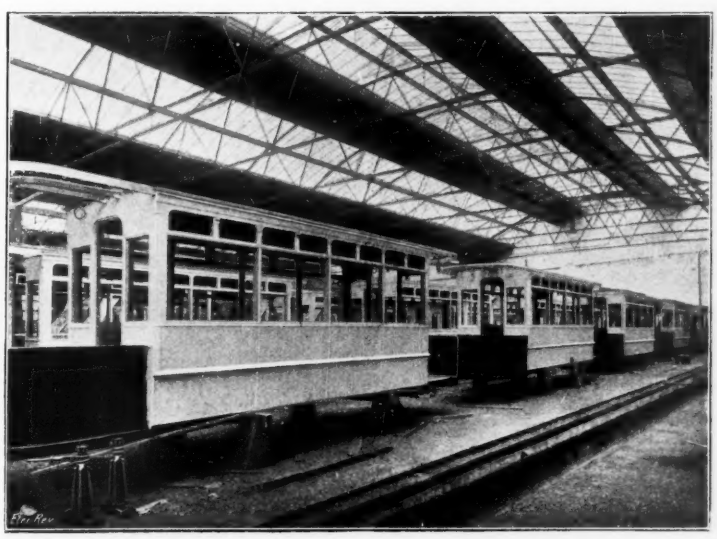


Fig. 9.—Cars Taking Shape.

We illustrate in fig. 14 a finished double-decker as it appeared before preparing for its dispatch to Huddersfield for the Corporation lines which have just been opened there. Every car before it leaves is tested on a tramway line specially constructed for the purpose.

The car bodies are lifted by the aid of Mr. C. Bush's

patent lifting jacks. These jacks are made entirely of steel, their chief feature being that the weight is carried by the spindles, and the strain is a tensile one. The spindle is suspended on ball bearings, which are completely enclosed, so that the lubricant cannot escape, and all dust is excluded. They are made in three sizes, 20, 12 and 6-ton, and the smallest is the most suitable for car sheds and repairing shops.

The bodies are conveyed from the car shed out to the main avenue, where they are taken in tow by the electric gantry crane, and placed upon railway trucks specially constructed by Messrs. Milnes for the London and North-Western Railway.

Among the orders which are now executing at Hadley may be mentioned 210 cars for the Manchester Corporation, 40 for Blackburn, 35 for Croydon, 25 for Chatham, 25 for Brighton, 30 for the London United Tramway Company, and 20 for the City and South London Railway Company.

It should be mentioned that all the different offices and departments are in telephonic communication.

It now only remains for us to describe briefly the electric power station, from which energy is supplied for driving the different machines, and so on. The lighting of the works is effected by means of nearly 800 incandescents and 100 British Schuckert differential arc lamps, arranged four in series, and controlled by double-pole switches. There are 50 continuous current motors of 460 H.P. aggregate capacity.

The boiler house equipment comprises three 30 ft. × 8 ft. Lancashire boilers designed for the consumption of wood cuttings, shavings, sawdust and other refuse, and having a working pressure of 120 lbs. per square inch. They are fitted with Green's economisers and mechanical stokers. They are supplied with water drawn from a large, specially constructed reservoir, and from a deep well by means of an electric pump, for feeding purposes.

Fig. 10.—View of the Smithy.

There are three B.T.H. six-pole continuous current shunt wound generators (fig. 15). They give 115 KW. at 230 volts at a speed of 400 revolutions. They are directly connected to three Browett - Lindley vertical compound condensing engines. As our photograph will show, the generating station is very roomy. It presents a very neat and clean appearance with its white glazed brick walls.

The switchboard, which is erected directly opposite to the generators, consists of a series of marble panels held together by a polished teak framework. There are in all four generator panels, each of which is provided with an automatic circuit breaker, main ammeter, positive and negative main switch, shunt field regulating rheostat, pilot lamp and discharge resistance. On either side of these panels the feeder panels are fixed. These are supplied with 24 double-pole switches, each of which controls the feeder line of both the light and power plant. Any one machine can be worked either on power (left-hand side of board) or light during the day, the power and lighting bus bars being, however, as a rule connected by means of switches. A spare generator panel has been left.

Fig. 11.—Electrically-driven Iron-working Machines.

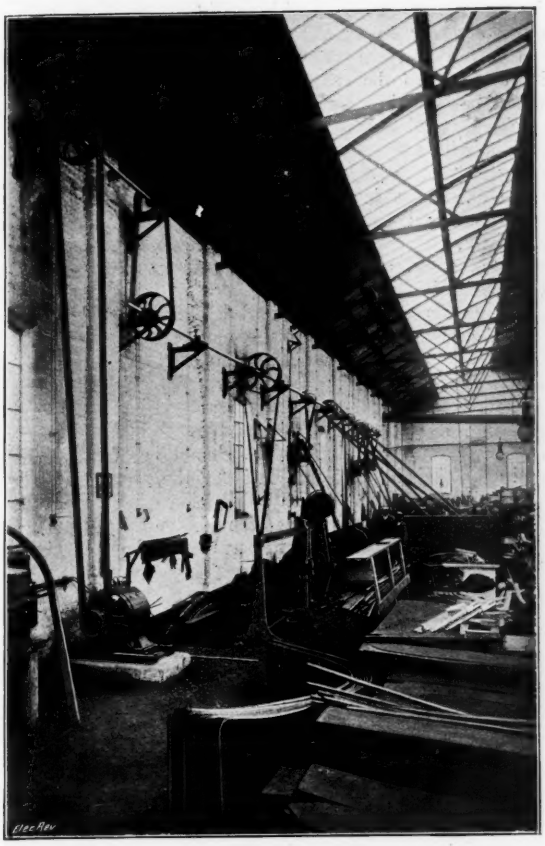


Fig. 12.—Motor-driven Shafting.

and laid in the ground. The main boards in the different departments are furnished with main and sub-switches to regulate the different power and light circuits. The wires

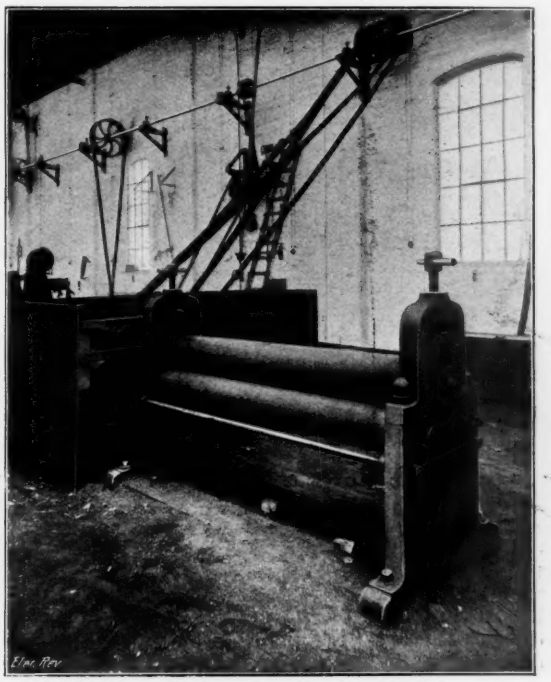


Fig. 13.—Bending Machine.

and cables running overhead outside the buildings, for arc lighting, &c., are protected by lightning arresters.

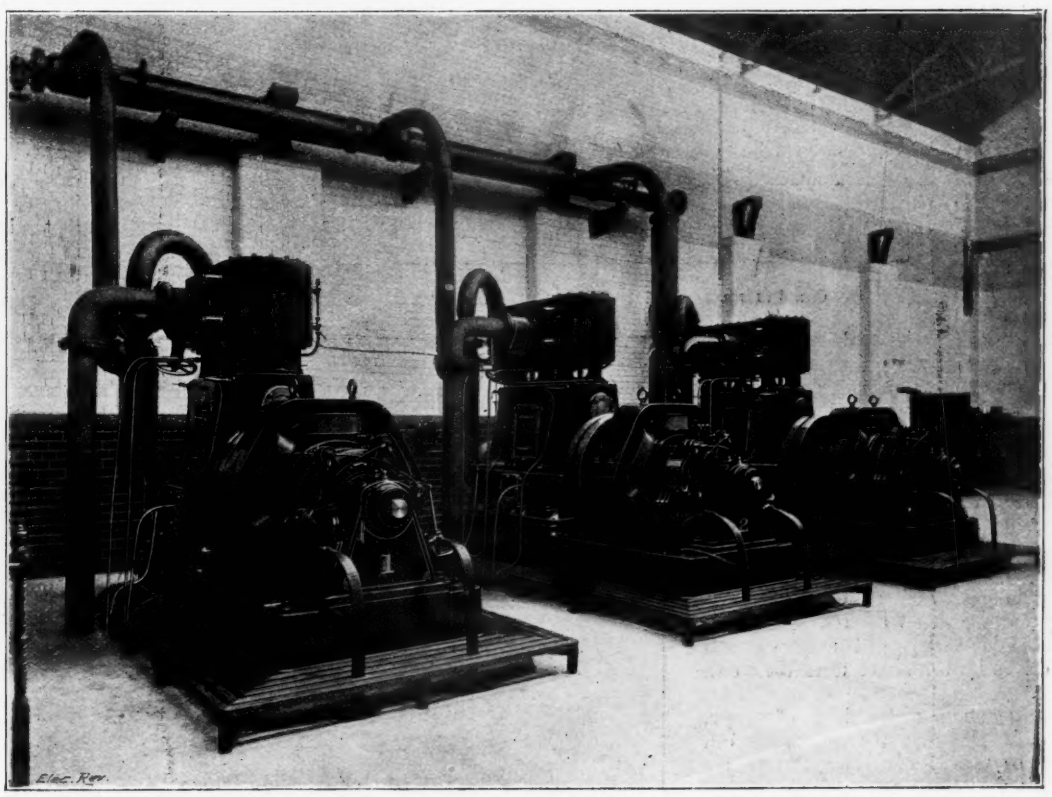


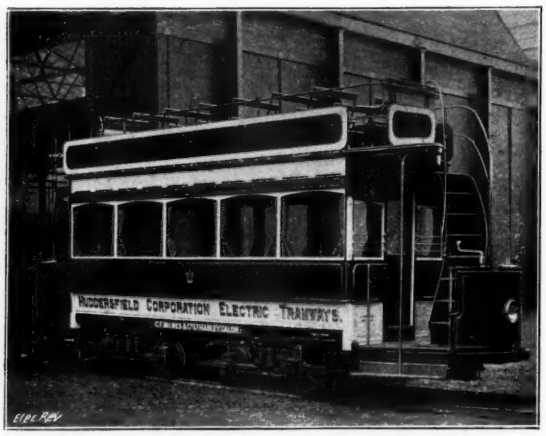
Fig. 15.—Electric Generators.

The cables from the main board to main distributing boards in each department are armoured and lead-covered,

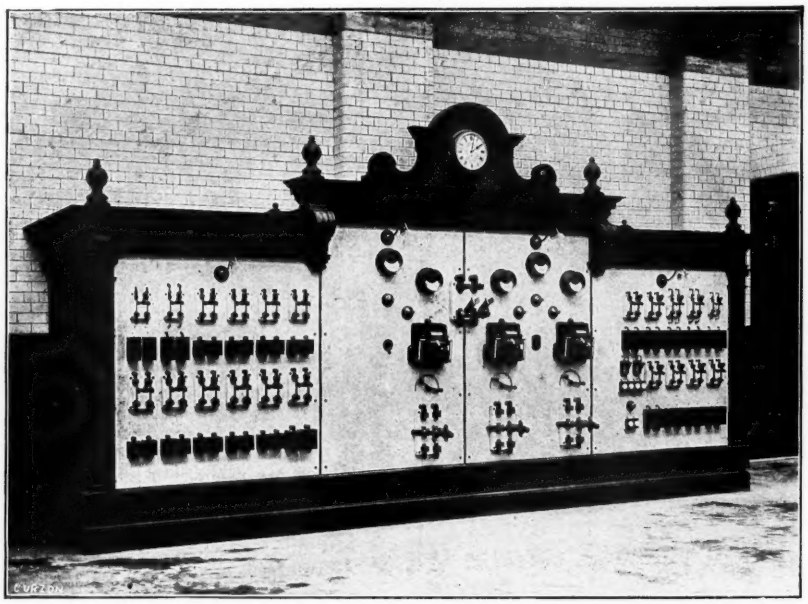
Mr. J. W. Kidd is the engineer-in-chief to Messrs. Milnes at the Hadley works.

ELECTRICALLY-DRIVEN MACHINE TOOLS.

A paper on this subject was read recently by Mr. G. Ralph before the Newcastle Section of the Institution of Electrical Engineers. The author does not profess to do more than collect scattered experience and draw attention to the benefits of electrical driving. With this view, he has something to say on the question of the individual driving of machines. For large machines this is, of course, the best system to employ, but in the present condition of the motor industry, it certainly seems best to drive many machines from one shaft and use motors of fair size to drive that shaft. Indeed, for small machines the aggregate power or capacity of individual motors would considerably exceed that of the one larger motor, and it is sound practice to keep as closely as possible to one size of motor. At the same time, it is not well to carry the shaft principle very far. We have in mind one of the latest examples of a machine shop, where the machines are grouped on so many line shafts, but there are no bevel wheels to carry shafting round corners. All shafts are straight lengths and ungeared, and are driven by belt direct from their own motor.



Car Building: Fig. 14.—Huddersfield Car.



Car Building Fig. 16.—The Switchboard in Hadley Power House.

The separate motor has, of course, the advantage that the tool speed can easily be varied, and such motors are made with 15 to 20 regulating steps. From this Mr. Ralph argues in favour of direct current in place of alternate current motors, which he understands are so very inefficient if run below normal speed. Mr. Ralph, however, does not seem to see with sufficient clearness that a separate motor to each tool is not necessary to prevent the whole power apparatus being run if one machine is required to be run overtime. The utmost waste would be that due to the one length of shaft on which the machine was grouped. A good suggestion is made that for such special overtime a portable motor could be brought along and set to work on any machine tool to be thus run alone. An example of this is cited, the switches being also temporary and convenient of access to the machineman. Similarly, portable tools can be fixed to large and heavy pieces of work, and this would be impracticable but for electrical driving.

As regards separate or grouped driving, the author thinks that if a machine requires 2 H.P. and upwards it may have its separate motor, and he is very insistent as to the loss due to long lines of shafting. On this point we would for the present simply say that much depends on the truth of the shafting, its correct levelling and general alignment, the sufficiency of its bearings, which should be of swivel type, and upon their lubrication. It is for these reasons that we are inclined to advocate simple shafting of not too great a length and preferably driven at the middle of its length.

The central station power need not be anything so large as the motor capacity. Thus at the Baldwin Company's works generators of about 1,300 H.P. serve 3,100 H.P. of motors. In the Bullock Company's works the ratio is 1 : 4·8, but includes lighting. Ordinarily, a ratio of 1 : 2 will be sufficient. We may say that the same reasoning applies to the case of the group motor and the individual machine motors. The author advocates the one motor type of shop traveller in spite of all that is said in favour of the three-motor type which

Car Building: Fig. 17.—A Crowded Car Shed.

we personally approve, and there are a number of interesting descriptions of the application of motors to various machines. He advocates a heavy fly-wheel to a motor for driving large planing machines which call for three or four times the normal current at the moment of reversal.

A slab miller for surfaces of 18 in. to 20 in. was found to absorb 15 H.P. This machine was driven by two motors, one to drive the cutter, the other to drive the feed and table. An inserted cutter mill was found to consume one half the power of a fluted spiral cutter per unit weight of chips removed. This is because the chips are larger from the inserted cutters than from the ordinary cutter.

Reference is made to forms of gearing such as belting, pitch chains, Hans Renold chains, spur and friction gears, also to the somewhat novel Brown gear, which is said to be very efficient and to work well, though no figures are available as to its wear. This gear works by a peculiar wedging action of a loose roller in an outer case with a hard central spindle. It is necessary that the rollers should all be hard, for the pressure is considerable, and the rollers if soft are apt to fail. Hard rollers, however, run well. Generally, the paper, even if stating nothing new, is suggestive and interesting, and the author has, we think, been very successful in collating information of value, which will be useful to engineers projecting a system of electric driving. We recently published a somewhat similar paper by Mr. Geipel, who states that even less than 20 per cent. of the power may be lost in the shafting, but this is exceptional; the loss may be as much as 70 per cent., and in one case was as much at 75·6 per cent. He quotes Mr. C. H. Benjamin as to power consumption in machine shops, as already reproduced (Electrical Review, February 22nd, 1901).

Mr. Geipel is not a fanatic on the subject, for he admits a knowledge of places where electrical driving is hardly likely to pay. It will be noted that the loss in conductors is very different from the loss due to steam pipes. The smaller the load electrically, still less in proportion will be the loss in the distribution system. Steam pipe losses are increased if the pipes are enlarged, and they must be of a certain size, but an electrical conductor loses less the bigger it is. We can hardly agree, however, that so little as 19 to 24 lbs. of steam will be used per horse-power-hour at the motor shaft. Mr. Geipel derived this figure from an assumed consumption of 13 to 16 lbs. per indicated horse-power-hour, and an efficiency of 68 per cent. At the same time the single central engine will be far cheaper to run than many isolated engines on long steam pipes, and we need not, perhaps, be too critical on this point, but we must point out that it is too common an error of most electrical engineers to assume, as the basis of their favourable comparisons for electricity, that the steam engine will be run for the minimum of fuel—an assumption quite at variance with all practice, and hardly likely to obtain even in the best regulated works, while in a small works where the load is least steady, the fuel or steam consumption will be considerably augmented.

It is only in large works that a steady load is found, and it ought to be possible to supply a small works with energy from some public source at less than the small works can produce it for.

ELECTRIC TRACTION NOTES.

(*Continued from page* 456.)

Sunderland.—On 6th inst. the whole of the electrical tramways were opened for service after the last three sections had been inspected by Mr. Trotter and Major Druitt. The three sections named are the Hylton Road, Tatham Street, and the Southwick portions, and these have been finished for some weeks. Application was at once made to the Board of Trade to send an inspector down but they were unable to at once comply. As we stated last week, the Tramways Committee thereupon started the cars off and they ran for about a day and a half. The Mayor of Sunderland then intervened (*not* the B. of T.), and on his representations the service on the three sections ceased, until it was re-started on the 6th. The electrical service is very popular n the town, and a deputation has asked the committee to decide to run cars to the east end of the town. This is the shipping quarter, where there are very large docks, and it is urged that the proposed system will pay admirably. At present there is no other means of getting to the docks than by walking or by cab, and as the distance is a good mile the want of some accommodation is keenly felt. The estimated cost is about £9,000.

Leipzig.—The following table showing the development of the Leipzig Street Tramways since their beginning is taken from a pamphlet by Prof. Dr. Ernst Hasse, M.P., on "The Leipzig Canal Question."

Year.	No. of inhabitants of Leipzig.	Length of tram lines, km.	No. of passengers.	Receipts in marks.	Per head of inhabitants. Length of line, km.	No. of passengers.	Receipts in marks.
			(*a*) Great Leipzig Street Tramway.				
1872	166,783		677,543	126,611	0·109	8·57	1·60
1873	176,542		1,627,328	321,338	0·103	9·21	1·82
1874	186,301		1,848,159	363,504	0·097	9·92	1·95
1875	196,060		2,090,294	405,648	0·093	10·66	2·06
1876	205,279	18·19	2,105,533	399,955	0·088	10·27	1·94
1877	214,110		1,972,053	369,160	0·084	9·21	1·72
1878	222,941		2,005,787	375,842	0·081	9·00	1·68
1879	231,773		1,934,909	360,226	0·078	8·34	1·55
1880	240,603		2,133,135	391,972	0·075	8·86	1·62
1881	249,740	21·81	2,381,224	406,627	0·087	9·53	1·62
1882	259,093	25·92	4,100,572	609,205	0·100	15·82	2·35
1883	268,446	26·73	5,670,668	793,801	0·099	21·12	2·95
1884	277,799	29·93	7,498,760	1,030,341	0·107	26·99	3·70
1885	287,152	33·08	8,472,529	1,127,376	0·115	29·50	3·92
1886	298,757	33·08	9,685,962	1,256,918	0·110	32·42	4·20
1887	311,971	33·60	11,125,411	1,375,314	0·107	35·66	4·49
1888	325,185	34·51	12,262,010	1,490,150	0·106	37·70	4·58
1889	338,399	39·08	14,284,910	1,643,502	0·115	42·21	4·85
1890	351,613	42·43	16,600,566	1,825,147	0·120	47·21	5·19
1891	362,118	46·53	17,809,992	1,941,400	0·128	49·18	5·31
1892	370,683	46·53	18,347,833	1,980,113	0·125	49·49	5·34
1893	379,247	46·53	19,512,565	2,106,664	0·122	51·44	5·55
1894	387,812	46·53	19,924,238	2,153,168	0·119	51·37	5·55
1895	396,377	46·53	21,242,891	2,302,877	0·117	53·59	5·80
1896	404,941	47·33	25,033,672	2,827,791	0·116	61·82	6·24
1897	413,506	70·49	37,036,185	3,539,628	0·170	89·56	8·56
1898	422,071	75·88	38,004,631	3,613,301	0·180	90·35	8·59
1899	430,635	82·87	42,182,543	3,989,510	0·192	97·98	9·26
1900	439,200	83·25	44,446,513	4,197,006	0·208	111·32	10·51
			(*b*) Leipzig Electrical Tramway.				
1896	404,941	40·40	5,384,476	521,490	0·099	24·46	2·37
1897	413,506	56·40	11,341,880	1,031,220	0·136	27·42	2·49
1898	422,071	60·64	14,914,916	1,324,069	0·140	35·35	3·14
1899	430,635	70·81	17,763,102	1,563,518	0·164	41·25	3·63
1900	439,200	65·76*)	19,121,895	1,679,226	0·164	47·91	4·20
			(*c*) Both Tramways together.				
1896	404,941	87·72	30,418,148	3,049,281	0·216	86·29	8·61
1897	413,506	126·89	48,377,515	4,570,848	0·306	116·99	11·05
1898	422,071	136·52	52,919,547	4,937,370	0·320	125·70	11·93
1899	430,635	153·68	59,945,645	5,553,028	0·356	139·23	12·90
1900	439,200	149·01*)	63,568,408	5,876,832	0·373	159·23	14·71

* The section Bluecherplatz-Schleussig was abolished.

Wallasey.—The L.G.B. has sanctioned the Council's proposed loan of £18,200 for electric traction purposes. The period of repayment is 25 years.

Wolverhampton.—The report of the Tramways Company states that the negotiations with the British Electric Traction Company, Limited, regarding the price to be paid for the remainder of the undertaking have now been satisfactorily settled, the Traction Company having agreed to pay the company the sum of £10,200.

The T.C. has authorised the Tramway Committee to accept tenders for the construction of the Dudley Road and Cleveland Road and other routes.

Worthing.—The T.C. is going to apply for light railway powers.

TELEGRAPH AND TELEPHONE NOTES.

Aberdeen Telephones.—A Committee of the T.C. is to report on the question of municipal telephones.

Bristol Telephones.—The City Council on Tuesday decided to appoint a committee to inquire and report on the extent to which telephonic communication is used by Bristolians and the payments made therefor; and to consider the expediency of applying for a license to enable the Council to provide a system. The subject was introduced by one of the labour members, Mr. Pope, but the Council paid but languid attention to the mass of facts and figures by which he supported his resolution. More interest was caused, however, by the speech of Alderman Pearson, who gave his support to the proposal, and who expressed a hope that the matter would be entered upon, not with a view to vilify the National Telephone Company (whose system, he admitted, acted like an incubus on trade), but to secure the benefit of competition, of whose advantages so much was heard. It was stated that telephonic communication costs the Bristol Council at present a total of £920 a year.

The Cable Communications Committee.—A meeting of this Committee was held on Tuesday. Evidence was given by Mr. B. Plummer, honorary secretary of the Associated Chambers of Commerce, and secretary of the Newcastle Chamber of Commerce; and Mr. E. Helm, secretary of the Manchester Chamber of Commerce.

The Cape-Australian Cable.—In the House of Commons on Monday, Sir Edward Sassoon asked the Secretary to the Treasury whether, in view of the importance of the projected Cape-Australian cable as constituting a link in the All-British system, he would lay upon the table of the House a copy of the agreement with the contracting company; and whether permission had been granted for landing rights on each and all of the intervening mid-ocean stations, and what terms and conditions had been attached thereto in the protection of the public interests. Mr. Chamberlain in reply said:—No formal agreement has been signed between His Majesty's Government and the Eastern and Eastern Extension Cable Companies in regard to the Cape-Australian cable, but I have informed the contracting company that landing rights at Mauritius, Rodrigues, and Cocos Islands will be granted on condition that the sliding scale rates in force in regard to the traffic between England and South Africa are extended to these places. It is intended that the landing licenses shall contain the same conditions and stipulations in favour of the Government and the public as the license about to be issued by the Board of Trade to the same company for the new cable from Madeira to Porthcurnow. The Government had not required the insertion in the contract of a provision reserving the right of purchase to the Government.

Manchester Telephones.—A meeting of the Manchester Corporation Special Committee *re* Telephones has been held, at which the question of overhead wires and their dangers, as demonstrated by the recent accidents in Liverpool, was discussed. An opinion seemed fairly general among the members that all telephone wires at present overhead should be taken down and placed underground. Representatives were appointed on a joint sub-committee from various other committees, whose object shall be to consider and report upon the practicability and the best methods of accomplishing this change.

The Pacific Cable.—The *Times* Ottawa correspondent says that on 5th inst. the resolution for increasing Canada's guarantee with reference to the Pacific cable, so as to cover the actual cost of the work, passed the House of Commons. Mr. Mulock announced that, instead of the Commission's borrowing money to carry out the undertaking, the Imperial Government proposed to raise the necessary capital, the various Governments interested undertaking to pay their proper share to the Imperial authorities. In the discussion several members expressed regret that New South Wales had made concessions to the Eastern Extension Company for the land line business in that State. Objection was also taken that no penalty was included in the contract with the construction company, to be imposed in the event of the company's failing to complete the work within the specified time. Mr. Borden, leader of the Opposition, said that a penalty clause should have been inserted, but even as it was the construction company would be liable in damages.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
St. Louis (Senegal)-Bathurst	Aug. 25, 1900	
Pará-Maranham	March 1, 1900	
Latakia-Cyprus	June 20, 1899	
Marseilles-Barcelona	Jan. 7, 1901	
Aden-Zanzibar	March 1, 1901	March 7
Fao-Bushire	March 7, 1901	
Landlines:—		
South American—Communication with Cartagena and Baranquilla	Dec. 8, 1900	
Chinese—Tientsin-Pekin	June 11, 1900	
Pekin-Kalgan	June 14, 1900	
Kalgan-Maimatchin	June 20, 1900	
Tientsin, *via* Shanghai	June 16, 1900	
Tientsin and Taku *via* Helampo	June 18, 1900	
All lines connecting Cochin China with Thuanan	Oct. 23, 1900	
Communication "*via* Hanekine" interrupted on Persian territory	Feb. 26. 1900	
Moulmein-Bangkok	Feb. 23, 1901	
Saigon-Bangkok	March 13, 1901	
Indo-European Co.—Kertch-Teheran	March 11, 1901	March 11

The Telegraph Wire Export Trade.—We have often referred to the fluctuating character of the export trade of this country in telegraph wire and apparatus connected therewith. This is again well shown by the returns for February, during which month the shipments only attained a value of £126,510, as compared with £596,122 in the preceding month and £502,816 in February, 1900. For the two months ending with February a total of £722,632 is shown, as against only £556,879 in the first two months of last year.

Telephones in Sick Rooms.—At the Trelleborg Hospital in Sweden, telephones are erected in the separate sick rooms at a small charge, to enable the patients to pass the tedious hours in calling up friends for a talk.

Wireless Telegraphy.—The Admiralty has decided to establish wireless telegraph stations at Dover, Portland Bill, Rame Head, Scilly, and other places.

Turkish Telegraphs.—The *Levant Herald* announces that the Turkish Administration of Posts and Telegraphs intends to lay a new line to place the Ottoman telegraph system in direct connection with India, and has asked for a credit to carry this intention into effect.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—March 15th. The E.L. Committee wants tenders for fuel economiser and Babcock & Wilcox boilers. See "Official Notices" February 15th.

Amsterdam (Holland).—April 1st. The Communal Council will on this date consider tenders for the supply and erection of all the motors necessary, and the installation of the electric lighting of the power station, switchboards, &c. Conditions from the Municipal Printing Office, 10 florins (16s. 8d.). Information from the manager of the office of Electricity, Achterburgwal, 213, Amsterdam.

Ayr.—March 20th. The Corporation wants tenders for boilers, stokers, condenser, pumps, battery, balancer, and booster. See "Official Notices" March 8th.

Burnley.—March 23rd. The Tramways Committee wants tenders for overhead equipment for electric tramways. See "Official Notices" March 1st.

Burnley.—March 23rd. The Tramways Committee wants tenders for rail bonds and cables. See two "Official Notices" March 8th.

Buxton.—March 23rd. The Council wants tenders for an electrically-driven triplex pump (17 H.P.). See "Official Notices" March 8th.

Cardiff.—March 18th. The Corporation wants tenders for steam, exhaust and other pipes, engine house flooring, switchboard gallery, &c., for electric tramways department. See "Official Notices" February 15th.

Colwyn Bay.—March 22nd. The U.D.C. wants tenders for one 120-KW. steam dynamo, and switchboard extensions. See "Official Notices" March 8th.

Gorton.—March 22nd. The U.D.C. wants a supply of electricity for its district for lighting, for 5, 7, 9 or 12 years. See "Official Notices" March 8th.

Gravesend and Northfleet.—March 25th. The B.E.T. Co., on behalf of the Gravesend and Northfleet Electric Tramways Company, wants tenders for the construction of new tramways and reconstruction of existing lines, and for the supply of electrical equipment. See "Official Notices" March 8th.

Halifax.—March 26th. The Corporation wants tenders for telephone and other cables. See "Official Notices" to-day.

Holland.—March 25th. Tenders are being invited until March 25th next by the municipal authorities of Amsterdam, for the equipment of a central electric lighting station in the city.

Hornsey.—April 11th. The U.D.C. wants tenders for dryback boilers, pumps, economiser, 300-KW. steam dynamos, motor transformers, condensing and water cooling apparatus, pipework, switchboard, battery, crane, mains, arc lighting, meters and workshop equipment, &c. See "Official Notices" to-day.

Kirkcaldy.—April 15th. The Corporation wants tenders for two 80-I.H.P. and three 250-I.H.P. engines and continuous current dynamos, storage battery, and 15-ton crane. See "Official Notices" to-day.

Launceston (Tasmania).—April 22nd. The Corporation wants tenders for the supply of 500 electric meters. See "Official Notices" January 11th.

Leeds.—April 15th. The City Council wants tenders for steam and other piping, pumps, economisers, &c., all for engines of 4,000 I.H.P. See "Official Notices" to-day.

Leith.—The T.C. wants tenders for a 350-KW. steam dynamo for lighting or traction. See "Official Notices" to-day.

Manchester.—March 25th. The Electricity Committee is inviting tenders for the following for Bloom Street station:—(*a*) switchboard for connecting four 1,800-KW. generators to the lighting and traction systems; (*b*) four continuous-current motors for driving mechanical stokers and economisers. Specifications, &c., on application to Mr. F. E. Hughes, secretary Electricity Department, Town Hall. £1 1s. for each specification.

Newport.—March 25th. The Corporation wants tenders for steelwork, bunkers, flue, coal conveyer, crane, water-tube boilers, stokers, economiser, tanks, compound condensing vertical engines, electric generators, condensing plant, feed pumps, &c., for electric tramway and power works. See "Official Notices" March 8th.

Roumania. — April 3rd. Tenders are again being invited until April 3rd by the municipal authorities of Ploesti, for the construction of an electric tramway in the town and the working of the same during a period of 30 years.

Roumania.—April 10th. Tenders are being invited until April 10th by the municipal authorities of Piatra Neamtz for the concession for the electric lighting of the town during a period of 30 years.

Shipley.—March 19th. The U.D.C. wants tenders for terminal boxes and switchgear, motors, meters, wiring, cables, wires, &c. See "Official Notices" March 1st.

Stockton-on-Tees.—March 26th. The E.L. Committee wants tenders for an additional 300-kw. steam dynamo. See "Official Notices" to-day.

Sunderland.—March 29th. The Corporation wants tenders for india-rubber-covered cables, stoneware casing, wrought-iron piping, and cast-iron piping, box frames and covers. See "Official Notices" March 1st.

The Hague (Holland).—March 25th. The Communal Council administration wants tenders for the supply and erection of engines and electric plant for the electric lighting of the town.

Warrington.—March 27th. The Corporation invites tenders for steel rails and permanent way work; poles, brackets, trolley wire, insulators, &c.; electric tramcars. See "Official Notices" March 1st.

West Ham.—March 22nd. The Council wants tenders for cables, cut-out boxes, wattmeters, transformers, wire and wiring accessories, and engine-room stores. See "Official Notices" March 8th.

Wigan.—March 27th. The Corporation wants tenders for paper cables, trolley line, steel poles, and castings. See "Official Notices" to-day.

Wolverhampton.—March 23rd. The Tramways Committee wants tenders for the overhead equipment of 5 miles of route, also feeders, conduits and switch pillars. See "Official Notices" March 8th.

CLOSED.

Batley.—The Corporation engineers have been instructed to prepare estimates of the cost of laying and equipping electric tramways authorised by the 1900 order, and the Town Clerk is to apply to the Local Government Board for the necessary loan. The tender of Messrs. John Fowler & Co., Limited, Leeds, for the supply and fixing of steam dynamos and balancer, motor-generator, &c., has been accepted. Instructions have also been given to the engineers to prepare plans for the proposed generating station. The Corporation intend to proceed with the scheme at once.

Bradford.—The Corporation has accepted the tender of Messrs. Willans & Robinson, Ltd., to supply for the sum of £2,422 two 300-h.p. steam engines for the Varley Road Electrical Works, and of Messrs. D. Bruce Peebles & Co., to supply two 200-kw. dynamos for same for £1,780.

The Corporation has also accepted the offer of Mr. Leonard Cooper for the supply of a half-mile length of portable tramway track for £713 2s; and that of Messrs. R. W. Blackwell & Co., Ltd., to supply for the overhead equipment poles made by the British Mannesmann Tube Company, Limited, in lieu of Messrs. Stewart and Menzies, poles which were originally accepted.

Great Yarmouth.—Messrs. W. H. Allen, Son & Co., Limited, have obtained the order for two 300-h.p. engines for Great Yarmouth, with dynamos by The British Schuckert Electric Company, Limited.

Manchester.—Messrs. George Russell & Co., engineers, Motherwell, have received an order for 22 electric cranes for the Manchester Ship Canal.

Newcastle-on-Tyne.—The Tramways Committee has accepted the tender of Messrs. James Russell & Sons, Limited, for 400 electric tramway poles at £9 13s. each, and 25 at £14 3s. 3d. each.

Sheffield.—The Tramways Committee has just placed orders for 25 additional double-deckers, which will bring the total number of cars to 145. The cars are to cost about £640 each. They are contracted for in three portions—car bodies, trucks, and motor equipments. The accepted tenders for the present order are as follows:—G. F. Milnes & Co., Limited, Birkenhead, 25 double-deck car bodies at £253 10s. per car; the Brill Truck Company, 25 Brill trucks at £58 11s. per truck; and the British Thomson-Houston Company, Limited, 25 "G.E. 58" double motor equipments, £330 each. The total cost of the 25 new cars will thus be £16,051. A large contract has been given the Leeds Steel Company, their tender to supply rails and fish-plates at the sum of £24,156 having been accepted.

Wolverhampton.—The T.C. on Monday accepted the following tenders:—Messrs. Thomas Parker, Limited (£374), for extension of the switchboard at the generating station; Electric Construction Company, Limited (£3,240), for a new 500-kw. generator with a Davey-Paxman engine; Messrs. H. Willcock & Co., of Wolverhampton (£1,332), for alterations and additions to the generating station; and Mr. Herbert Holloway, of Wolverhampton, amounting to £54,838 10s. 10d. for the construction of the electric tramway permanent way from the Upper Green, Tettenhall, to the borough boundary at Bilston Road, *viâ* Tettenhall Road, Newhampton Road, Darlington Street, Lichfield Street, Piper's Row, and Bilston Street. The chairman of the committee (Ald. C. T. Mander) stated that Mr. Holloway's tender was £21,000 lower than that of the highest tender sent in.

FORTHCOMING EVENTS.

Friday, March 15th.—At 8 p.m. Institution of Mechanical Engineers, Storey's Gate, S.W. "Combined Trolley and Conduit Tramway Systems," by Mr. A. N. Connett, of London.

Saturday, March 16th.—At 6.30 p.m. Institution of Junior Engineers. Anniversary Dinner at the Westminster Palace Hotel.

Monday, March 18th.—At 8 p.m. Society of Arts. Cantor Lectures. "Electric Railways," by Major Philip Cardew, R.E., M.I.E.E. Lecture II.—Multiple unit system—Compressed air control—Line equipment—Third rail and overhead conductors—Limitations of electrical pressure—Return circuit—Fall of potential must be kept very small—Booster arrangement—Ganz's trolley pole and other details of system—Generation and transmission—Distance apart of stations—Sub-stations—Transformers—Rotary converters—Accumulators.

Tuesday, March 19th.—At 8 p.m. Institution of Junior Engineers. Lecture IV. on "Works Management," by Mr. A. H. Barker, Wh.Sc., B.A.Sc.

Wednesday, March 20th.—At 7.30 p.m. Institution of Electrical Engineers. Students' meeting. Paper: "Indoor Electric Light Fittings at the Paris Exhibition," by G. E. Turnbull.

Friday, March 22nd.—At 8 p.m. Institution of Junior Engineers. At the Westminster Palace Hotel, Engineering Question Night.

NOTES.

To our Correspondents.—We shall be glad if our readers will bear in mind that letters intended for our "Correspondence" columns should reach us by 3 p.m. on Wednesday *at latest*. Several letters have to be held over until our next issue on account of late arrival.

The Physical Society.—At last Friday's meeting Mr. Rollo Appleyard exhibited three pieces of apparatus. The first was a slide wire bridge for measuring conductivities of wires. The slide wire, instead of forming two arms of the bridge, forms only one, and the length used is proportional to the conductivity to be measured. If the arm which contains the standard wire used is altered, it becomes necessary to alter the divisions of the scale on the slide wire. This is done by a mechanical arrangement. The second piece of apparatus was a mechanical gauge for measuring the diameters of spheres. The sphere to be measured is placed between a metal face plate and a piece of glass at the end of the short arm of a pivoted lever. The end of the long arm of the lever moves over a graduated scale, which is calibrated to show directly the diameter of the sphere. The third piece of apparatus was a galvanometer fitted up for lamp and scale work. The illumination was produced by a 4-volt ¼-c.p. lamp, and it was shown that very good results could be obtained from this by using a large condensing lens. Prof. Threlfall said he had usually used a straight piece of the lamp filament itself, instead of using the lamp in conjunction with a cross wire. The next meeting will be held on March 22nd, in the chemical laboratories of University College, London.

American Competition.—"Britisher Abroad" sends a most interesting letter on this very pressing subject to *Engineering*. It is so opportune and so much to the point that we reprint it, and recommend English electrical manufacturers to give it that attention which words from a man on the spot, and evidently well in the know, deserve:—

Whilst many realise that American competition is a real thing, others are inclined to regard it lightly, and it is a pity such influential men as Sir Lowthian Bell do not take greater pains to impress upon us younger men the severity of this competition. On the other hand, we do not wish to be told that England is on the downward grade; this is not so. Perhaps never before have British-made goods abroad shown up so well as they are doing now; the trouble is that other nations' goods are getting a good look in. There seems to be a remedy, if our manufacturers would adopt the tactics of their foreign rivals. In the first place, let us keep always before us the words of Mr. William Fowler (quoted in *Engineering* a week or two ago): "One of the greatest things to combat foreign competition was that they should maintain their character for the high quality of English work."

Secondly, English-made goods must be sold at such a price as will compete with those of foreign origin, even though the latter be inferior in quality.

Thirdly, British manufacturers must not sit at home and think their goods will sell themselves: they will not. Let all firms send out competent travellers, who can speak the language of the country they are going to visit; men who are real workers and thoroughly know their business, and who have some authority to quote competitive prices, and do not have to refer everything to "my people" (I am looking at the question from a buyer's point of view). Finally, pay them well enough to be "aggressive," as the Americans say. Travel is good for everyone; and the more people see of the world the better.

I throw out the following suggestion, to be taken up, if it is any good, by British manufacturers: Let there be formed an institute or association for the collection and dissemination of matters of commercial interest, and which would supplement consular reports; let all communications be printed and freely circulated amongst home *manufacturers* (not American and German importers) and British merchants abroad. It would be the means of finding out the wants of people in foreign and new countries, and also a means, perhaps, of finding an outlet for surplus stocks. I am prepared to give at least one evening per week to writing out a description of engineering wants of the locality, what people are doing business, &c., and I would make detailed and dimensioned drawings of such foreign goods here as I have access to, if required, and when possible give net prices. There must be dozens of young men in all parts of the world who would do the same.

Americans, according to their own showing in the New York papers, do not seem to be able to get a footing at all in Australia in certain branches; would it were the same here. I am inclined to think that British people do not stick to each other, like Germans, for instance; we are not "clannish" enough. As an instance of what the American Consul does for his countrymen, he not only sent full particulars of 24-ft. iron telegraph poles used in South Africa, but he actually sent a dimensioned sketch, which was freely published. It is time someone did this for Britain.

Lectures, &c.—On Wednesday evening Mr. C. N. Russell read a paper before the Association of Parochial Engineers and Engineers-in-Charge at the St. Bride Foundation Institute, the subject being "Dust Destructors."

Before the Glasgow University Engineering Society on 8th inst., Mr. M. B. Field read a paper on "Electric Traction."

Major Philip Cardew delivered a lecture before the Society of Arts on Monday on "Electric Railways." This was the first of a course of three Cantor Lectures upon the subject. The lecturer showed a series of lantern slides illustrating what has already been done in Switzerland.

At a meeting of the Manchester Association of Engineers last week Mr. Daniel Adamson introduced a discussion on the comparative merits of electric and rope-driven travelling cranes.

Institution of Electrical Engineers (Glasgow Section).—On Wednesday, 13th inst., a paper was read on "Notes on Some Systems of Laying Underground Mains," by Mr. Arthur Devey.

Newcastle Section.—On Monday Mr. J. A. Jeckell, borough electrical engineer, South Shields, read a paper at the meeting of the Institution of Electrical Engineers, Newcastle. The paper was a description of the electricity works at South Shields.

Municipal Electrical Association.—The annual convention of this Association is to be held in Glasgow from June 19th to 21st.

The Belleville Boiler.—The Water-Tube Boiler Committee's interim report shows that they consider that some type of water-tube boiler should be used in the Navy, and that the Admiralty at the time the decision was made were justified in choosing the Belleville make, but on the evidence now available they do not consider it "has any such advantage over other types of water-tube boilers as to lead them to recommend it as the best adapted to the requirements of His Majesty's Navy." Consequently they advise that the Belleville type be retained in ships built or in an advanced stage of construction, but that it be not fitted in vessels recently ordered, or in any future ships. They propose to experiment with boilers of the Babcock & Wilcox, Niclausse, Dürr, and the Yarrow large tube types.

Effects of the Steel Trust.—At the annual meeting of Messrs. William Jessop & Sons, Sheffield, on Tuesday, the directors announced that they contemplated establishing works for certain branches of their business in the United States, where the whole of the crucible steel makers in the States had gone into a large combination, and had compelled them to come to this conclusion.

The *Standard's* Odessa correspondent announces that another Sheffield firm, Messrs. C. Cammell & Co., is about to establish there large works for the manufacture of edge tools, &c., making a speciality of files, starting with 78 artificers. The correspondent has also been informed that several other British industrial firms are thinking of following the example.

What Does this Mean?—The London County Council on Tuesday postponed the consideration of the following remarkable notice of motion, which stands in the name of Mr. R. Spokes:—

That it be referred to the Local Government Committee to report (*a*) whether any means at present exist of ascertaining the names and addresses, and nature and extent of interest of debenture stock and shareholders in the companies supplying gas or electricity, or water or hydraulic power, or undertaking tramway or telephone service, or owning docks or wharves within the county of London, and if not, (*b*) as to the desirability of the Council seeking Parliamentary powers to bring all such companies, whether incorporated by private Act of Parliament or otherwise, under similar obligations in that respect as would be the case had they been incorporated under the Companies' Acts, 1862 to 1900.

Personal.—The Manchester City Council have made the following advances in the electricity department:—Mr. W. F. Long, assistant engineer, from £210 to £235; Mr. J. A. Constantine, steam assistant, from £220 to £240; and Mr. I. A. Cookson, draughtsman, from £200 to £225.

Mr. Robert Culloch, chief clerk in the electricity department of Leith, has been appointed assistant electrical engineer under the Woolwich Borough Council.

The Morecambe D.C. has selected Mr. Richard Pape, of Hull, from 100 applicants, for the post of resident electrical engineer. The other candidates appearing before the committee on March 8th were:—Mr. Robertson, of Stirling; Mr. Denton, Whitehaven; and Mr. Grainger, Morecambe.

Electrical Engineers and the War.—Colonel R. E. Crompton delivered a lecture on Monday night at the Camera Club on "Scientific Engineering in the South African War." The experiment of taking out to the front a highly-trained body of scientific men, such as the Electrical Engineers, the lecturer said, had turned out a very great success, and it was a consolation to know that in the trained engineers of the country they had, in case of a serious war, a reserve of fine material on which to draw. The lecture was illustrated by lantern views.

To Central Station Superintendents.—With reference to our last week's note under this heading, we understand from later information that the competition is confined to members or associate members of the American Institute of Electrical Engineers or the National Electric Light Association.

A Useful Metal.—One of our contemporaries, a professedly technical journal this time, has recently offered the following interesting contribution to the literature of aluminium:—"It has often been stated and written that aluminium is to be the metal of the future. Up to the present this prognostication has scarcely been justified; aluminium has only taken a modest place amongst the ordinary metals, replacing, for particular applications, sometimes copper, sometimes steel, iron, or zinc. Already it plays an important *rôle* in the manufacture of alloys, and one is able to foresee the day when its application will become general for aerial electric conductors. M. Heroult justifies this view when he observes that the electric conductibility of aluminium in equal proportion is 60 per cent. that of copper. In comparing their density, it is seen that an electric line in aluminium would weigh at equal rate of conductibility a half less than a line in copper; there is, then, in actual extent an evident advantage in favour of aluminium. Nor is that the only advantage of this metal, for a comparison of weights and resistance in traction also shows that its employment permits of an increase in its scope." We cannot help thinking that if aluminium could be used as an "aerial" conductor, it would be better than copper, even were its "conductibility" more than "a half less" (this is intended to mean "one-half of") that of the older metal; for a total abolition of all poles and supports ought to be a great economy and convenience in cities, although perhaps the conductors would get hopelessly mixed together and lost after a prolonged gale. "Resistance in traction" appears to suggest that aluminium should not be used in the construction of motor car parts, lest the vehicles should be too costly to haul about. When we read that the wider employment of aluminium permits of an increase in its scope, we seem to remember that most things become larger as they grow, although once upon a time Alice did have to run as fast as she could to keep in the same place. The value of aluminium as an "aerial conductor" seems also to have some bearings upon the question of wireless telegraphy, but we cannot now stop to consider this important matter with the care it evidently demands.

Appointments Vacant.—An electrical engineer is wanted by the Nelson Corporation at £300 per annum. The Wolverhampton Town Council on Monday authorised the General Purposes and Tramways (Joint) Committee to advertise for and to appoint, for such period as may be necessary, three clerks of works in connection with the construction of the new tramways, at a salary of £3 10s. per week respectively.

Glasgow Tramcars.—The Gloucester Railway Carriage and Wagon Company, Limited, have just completed 80 tramcar bodies with motor-cables and electric light wiring and fittings, for the Glasgow Corporation Tramways. These are a portion of the additional stock which has to be equipped in time for the Exhibition, and the anticipated heavy traffic.

Accumulator Competition.—The French Automobile Club is organising an international accumulator competition to begin on June 1st next. Full particulars can be obtained from the club headquarters, Place de la Concorde, Paris.

Institution of Electrical Engineers (Manchester Section).—The fortnightly meeting of the Manchester Section of the Institution of Electrical Engineers took place in the new physical laboratory of Owens College, on Tuesday evening, March 12th. Dr. E. Hopkinson presided. Mr. John S. Raworth read a paper on "The Application of Steam Power to the Generation of Electrical Energy," and a discussion followed.

Overhead Wire Accident.—A daily press telegram states that on Thursday night last week an exceedingly heavy snowfall took place in Vienna, causing great destruction of telegraph and telephone communication. Over 1,400 overhead wires were broken. Persons were injured and several horses killed by the falling wires of the electric tramway.

Society of Arts.—On Wednesday night Mr. F. B. Behr read his paper on "The Proposed High Speed Electrical 'Monorail' between Liverpool and Manchester." The chair was taken by Sir William H. Preece.

Partnership.—Messrs. Bergtheil & Young announce that as from January 1st, 1901, they have taken Mr. Robert O. Ritchie into partnership. Mr. Ritchie has for many years acted as manager of the electrical department of Messrs. Greenwood & Batley, Limited, of Leeds. He will take charge of Messrs. Bergtheil's Manchester branch.

Erratum.—A slight error occurred on p. 404 of our last issue. In the first column, paragraph 5, line 21, there should be no fullstop after the word "battery"; read straight on "by the employment of a storage battery there is not the slightest reason," &c.

Royal Society.—Yesterday afternoon a paper was read by Mr. C. E. S. Phillips on "The Action of Magnetised Electrodes upon Electrical Discharge Phenomena in Rarefied Gases."

NEW COMPANIES REGISTERED.

Pritchetts & Gold, Limited (69,517).—This company was registered on March 6th, with a capital of £40,000 in £1 shares (20,000 preference), to acquire and carry on the business carried on at Feltham as "Pritchetts & Gold," to adopt an agreement with G. E. B. Pritchett, T. W. Pritchett, A. G. Gold, and C. R. D. Pritchett, and to carry on the business of manufacturers of storage batteries and accessories, electrical engineers, manufacturers of electrical appliances and machinery, mechanical engineers, suppliers of electricity for light, heat, motive power, and other purposes, &c. The first subscribers (each with one share) are:—G. E. B. Pritchett, Clymping Dene, Feltham, electrical engineer; T. W. Pritchett, Clymping Dene, Feltham, electrical engineer; A. G. Gold, Croft House, Stanstead, Essex, gentleman; C. R. D. Pritchett, Clymping Dene, Feltham, electrical engineer; A. B. Bryden, 23, Bucklersbury, E.C., chartered accountant; F. C. G. Menzies, Wandle Bank House, Merton, gentleman; and J. W. Robison, 7, Norman Avenue, St. Margaret's, Twickenham, electrical engineer. No initial public issue. The number of directors is not to be less than three nor more than seven; the first are G. E. B. Pritchett, T. W. Pritchett, C. R. D. Pritchett, and A. G. Gold; remuneration (except managing directors), £100 each per annum (or £10 each per meeting attended, if less than nine). Registered office, Feltham, Middlesex.

New Electric Lamp Regenerating Company, Limited (69,525).—This company was registered on March 7th, with a capital of £80,000 in £1 shares, to adopt an agreement with C. W. Milne, and to carry on the business of lamp manufacturers, electrical and mechanical engineers, machinists, fitters, millwrights, iron, brass and metal founders, glass blowers, cable and conductor manufacturers, wire drawers, carbon manufacturers, electro-platers, porcelain manufacturers, chemists, &c. The first subscribers (each with 500 shares) are:—C. W. Milne, 51, Linden Gardens, W., gentleman; E. I. Bax, Eldon, Weybridge, gentleman; W. J. Davy, 52, Durham Road, East Finchley, N., engineer; F. Fanta, 6, Fulwood Rents, High Holborn, W.C.; L. B. Peters, Moorgate Works, Moorfields, E.C., engineer; E. Cadett, 17, Fenchurch Street, E.C., gentleman; and W. H. Thompson, 8, Dalebury Road, Upper Tooting, S.W., mortgage broker. No initial public issue. The number of directors is not to be less than three nor more than five; the first are C. W. Milne, E. I. Bax, W. J. Davy and F. Fanta; qualification, £500; remuneration, £100 each per annum (£50 extra for the chairman) and a share in the profits. Registered office, 3 and 5, Crown Court, Old Broad Street, E.C.

Public Undertakings Syndicate, Limited (69,509).—This company was registered on March 5th, with a capital of £10,000 in £10 shares, to carry on the business of constructors and controllers of public works and conveniences of all kinds, including railways, tramways, tramroads, docks, harbours, piers, canals, wharves, drainage, water, gas, electric light, telephones, telegraphs, electric power and energy supply, &c. The first subscribers are:—Meyer H. Goldstone, of 45, Dutton Street, Strangeways, Manchester, engineer, with two shares; Ernest O. Walker, St. Simons Electrical Works, Salford, Manchester, engineer, with one share; Frederick F. Bennett, 13, Victoria Buildings, Manchester, engineer, with one share; Walter Gunn, 55, Market Street, Manchester, engineer, with one share; Herbert Walmsley, Beechfield, Leyland, oil merchant, with five shares; James Iddon, Wellfield, Leyland, near Preston, engineer, with five shares; and Charles H. Stocks, 213, Deansgate, Manchester, engineer, with 20 shares. No initial public issue. The number of directors is not to be less than two nor more than four; the first are to be appointed by Percy F. Rouse (solicitor), with the consent of any one of the subscribers; qualification, £200.

Hedges, McKrell & Co., Limited (69,515).—This company was registered on March 6th, with a capital of £1,000 in £1 shares, to acquire the business carried on at 31 and 34, Barbican, E.C., by Hedges, McKrell & Co., and to carry on the business of electricians, electrical engineers, mechanical, sanitary, gas, steam and water engineers, makers of electric tramcars, motor cars, carriages, cycles and other vehicles, and manufacturers of and dealers in dynamos, motors, telephones, bells, pyrometers, calorimeters, thermometers, electroliers, arc and other lamps, electric light fittings, india-rubber and other insulating materials, chemical and medical apparatus, &c. The first subscribers (each with one share) are:—A. H. Sparkes, 28, Lowman Road, Holloway, N., electrical engineer; T. H. Rudkin, 10, Fawe Park Road, Wandsworth, S.W., builder; H. E. McKrell, 31, Barbican, E.C., electrical engineer; W. Hedges, 34, Barbican, E.C., electrical engineer; E. W. Riches, 155, Lea Bridge Gardens, Leyton, engineer; Mrs. K. McKrell, 10, Fawe Park Road, Wandsworth, S.W.; and F. J. A. Bult, 130. Plashet Grove, East Ham, E., clerk, No initial public issue, Registered without articles of association.

SUPPLY STATION ACCOUNTS.

Sheffield Corporation Electricity Accounts.

The Sheffield Corporation electricity supply undertaking is burdened with rather a high capital expenditure for its output. This seems to be a general result of allowing a company to start and then buying the business from it. Four concerns, with not widely varying outputs and located within approximately the same area, are:—

District.	Capital.	Output.	Average price received per unit.	Total cost.	Profit. Gross.	Profit. Net.
Halifax ...	£93,218	1,371,333	2·77d.	1·24d.	£9,001	£5,489
Leeds ...	£307,522	2,005,840	4·07d.	1·19d.	£26,291	£8,502
Nottingham	£166,098	1,491,184	2·87d.	1·41d.	£9,673	£2,151
Sheffield ...	£340,406	1,329,881	3·90d.	1·62d.	£14,321	£915

In the case of Sheffield, practically half the additional revenue in 1899 was swallowed up by greater expenditure, the other half went to swell the gross profits.

General Statement.

	1898.	1899.	Increase.
Total capital expenditure ...	£299,324	**£340,406**	£41,082
Number of units sold	978,088	**1,329,881**	351,793
No. of 30-watt lamps connected ...	73,853	**99,570**	25,717
Maximum load in KW.	1,073	**1,480**	407
Gross revenue	£18,902	**£23,292**	£4,390
Gross expenditure...	£6,734	**£8,971**	£2,237
Gross profit	£12,168	**£14,321**	£2,153
Average price per unit sold ...	4·10d.	**3·90d.**	−·20d.

The charges in 1898 were 5d. per unit for the first three months of the year, and 4d. afterwards. This latter price ruled in 1899. Sheffield is badly off in one respect, that the whole of its revenue comes from private supply, as traction is a separate department, and no attempt is made to indulge in public electric lighting. Discounts apparently account for the average receipts for sale of energy being less than the fixed price charged per unit.

Revenue Statement.

	1898. Gross	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Sale of energy	£16,715	4·10d.	**£21,597**	3·90d.	−·20d.
Meter rents	416	·10d.	**566**	·10d.	·00d.
Sales: Repairs and other sources.	1,572	·39d.	**989**	·18d.	−·21d.
Sundry: Rents and interest on overdue accounts.	199	·05d.	**140**	·02d.	−·03d.
Gross revenue ...	£18,902	4·64d.	**£23,292**	4·20d.	−·44d.

Coal and rent, rates, &c., have each increased by ·08d., and other expenses by half this amount, per unit. The coal bill is nearly down to Leeds at ·31d., while Sheffield beats Leeds on management expenses (·27d.), and is equal on establishment charges. Owing to sundry small reductions both works and total costs are below the 1898 figures.

Cost of Production.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Coal	£1,228	·30d.	£2,084	**·38d.**	+·08d.
Oil, waste, water and engine room stores.	445	·11d.	367	**·06d.**	−·05d.
Salaries and wages incurred in generation and distribution.	1,499	·37d.	1,827	**·33d.**	−·04d.
Repairs and maintenance of buildings, boilers, engines, dynamos, &c.	978	·24d.	1,331	**·24d.**	·00d.
Works costs ...	£4,150	1·02d.	£5,609	**1·01d.**	−·01d.
Rent, rates and taxes ..	548	·13d.	1,151	**·21d.**	+·08d.
Management expenses, salaries of managing engineer, secretary, clerks, &c. directors' remuneration and company auditors' fees	972	·24d.	809	**·15d.**	−·09d.
General establishment charges, stationery and printing, law charges and insurance	528	·13d.	443	**·08d.**	−·05d.
Other expenses: Bank charges, stamp duty, and commission for procuring loans	536	·13d.	959	**·17d.**	+·04d.
Total costs ...	£6,734	1·65d.	£8,971	**1·62d.**	−·03d.

In 1898 the gross profit had to provide interest on debenture debt and for a distribution of 10 per cent. to the shareholders of the late company in respect of that year, as was stated in the agreement for purchase. This left a balance of £1,331. Although the gross profit had improved by £2,153 the next year, interest and sinking fund had gone up together to £13,406, a sum £2,569 in excess of the interest and dividend in 1898, and this difference of £416, between the increased gross profit and greater payments to be met, caused the net profit to drop to nearly £900.

Profit Statement.

	1898.	1899.
Interest on debentures or on loans	£1,125	£9,410
Sinking fund for repayments	—	3,996
Net profit, dividend of 10 % to Co.'s shareholders	9,712	—
" carried forward	1,331	915
Gross profit	£12,168	£14,321

Worcester Corporation Electricity Accounts.

The accounts of the Worcester electricity undertaking are always exceptionally clear, and give detailed technical information respecting the progress of the department. We are glad to note that Mr. C. J. Sutherland resumed his position as city electrical engineer at the beginning of this year, but he will not lose the services of Mr. E. E. Hoadley, who acted as engineer during his absence, as the City Council has appointed the latter as chief assistant at his previous salary. The new generating station is in hand, but will not be completed for about 12 months.

General Statement.

	1899.	1900.	Increase.
Total capital expenditure ...	£79,236	**£82,630**	£3,394
Number of units sold	551,437	**625,739**	74,302
Number of lamps connected ...	31,202	**34,494**	3,292
Maximum load in KW.	440	**510**	70
Gross revenue	£8,378	**£9,669**	£1,291
Gross expenditure	£4,587	**£5,999**	£1,412
Gross profit	£3,791	**£3,670**	−£121
Average price per unit sold ...	3·52d.	**3·57d.**	·05d.

The free wiring contract has been terminated, but the Corporation wiring scheme—which we described about a year ago—has brought in some nine consumers during the latter six months of 1900. The total number of new customers obtained was 69, as against 51 in 1899. The charge for energy was increased towards the end of last year to cover the rise in the cost of fuel, and therefore the receipts show an improvement of $\frac{1}{10}$d. under this head. The average return from private supply is 4·48d. per unit, which shows the local advantages of the maximum demand system of charging. The output was distributed as follows:—

	Units generated.	Private supply.	Public lighting.	Number of public lamps.
1899 ...	710,416	441,837	109,600	57 arcs of 500 watts; 3 incandescents of 200 watts.
1900 ...	842,132	519,690	106,049	57 arcs of 500 watts; 3 incandescents of 600 watts, and 13 of 60 watts.

The units supplied to the public lamps have been calculated upon a new basis giving greater accuracy, and this explains the apparent decrease in consumption.

Revenue Statement.

	1899. Gross.	1899. Per unit.	1900. Gross.	1900. Per unit.	Increase.
Sale of energy	£8,089	3·52d.	**£9,314**	3·57d.	+·05d.
Meter rents	182	·08d.	**220**	·09d.	+·01d.
Sale of old material	10	·00d.	**34**	·01d.	+·01d.
Sundry fees, rents, &c. ..	97	·04d.	**101**	·04d.	·00d.
Gross revenue ...	£8,378	3·64d.	**£9,669**	3·71d.	+·07d.

The coal bill has affected the works and total costs in almost the same proportion as it has increased this item. The weight of coal per unit generated by steam has, however, only risen from 11·19 to 11·27 lbs. per unit generated by steam, the change being attributed to running the large Ferranti set under exceptional conditions.

Eliminating the public lighting costs, Mr. Sutherland shows that works cost stands at 1·73d. and total cost at 2·14d. per unit. "Free lamps" cost $\frac{1}{10}$d. per unit, which will in future be saved, as the giving away of lamps has been abandoned. The water-power plant was used to generate 49·13 per cent. of the total units, against 41·7 per cent. in the previous year.

COST OF PRODUCTION.

	1899. Gross.	Per unit.	1900. Gross.	Per unit.	Increase.
Coal	£1,626	·71d.	£2,678	1·03d.	+·32d.
Oil, waste, water and engine room stores	157	·07d.	217	·08d.	+·01d.
Salaries and wages incurred in generation and distribution and attending, &c., street lamps	1,263	·55d.	1,373	·53d.	−·02d.
Repairs and maintenance buildings, boilers, engines, dynamos, &c.	512	·22d.	593	·22d.	·00d.
Works cost ...	£3,558	1·55d.	£4,861	1·86d.	+·31d.
Rent, rates and taxes ..	86	·04d.	88	·03d.	−·01d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	460	·20d.	481	·19d.	−·01d.
General establishment charges, stationery and printing, law charges and insurance	236	·10d.	170	·07d.	−·03d.
Other expenses: Compensation, free wiring, lamps, &c.	247	·11d.	399	·15d.	+·04d.
Total costs ...	£4,587	2·00d.	£5,999	2·30d.	+·30d.

The gross costs increased more rapidly than the revenue, but as the sinking fund payment was less than in 1899 by £35, the gross profit was sufficient to meet all charges, and leave a sum, small though it be, as net profit. Had the coal bill not increased by £1,051, the profit would have run into three figures, and surpassed the results of 1899.

PROFIT STATEMENT.

	1899.	1900.
Interest on loans	£1,945	£1,945
Sinking fund for repayments	1,756	1,721
Net profit carried forward	90	4
Gross profit	£3,791	£3,670

CITY NOTES.

Potteries Electric Traction Company.

THE directors' report for the year ended December 31st, 1900, reads as follows:—

Profit and Loss Account.—The gross profits for the year amount to £64,151 4s. 7d. After deducting all expenses chargeable to revenue, including all repairs and maintenance and interest on debentures, there remains a net profit of £13,839 6s. 2d. To this has to be added the amount of £866 9s. 7d. brought forward from previous account, making an available balance of £14,705 15s. 9d., which the directors propose should be applied as follows, viz.:—

To provide for dividend for the year on the cumulative preference shares	£10,000 0 0
To pay a dividend on the ordinary shares of the company of 2 per cent. for the year	4,000 0 0
To transfer to the credit of the depreciation fund ..	500 0 0
To carry forward to next account	205 15 9
	£14,705 15 9

Owing to the strikes of potters and bricklayers throughout the months of April and May the traffic receipts suffered considerably, and the work on the new generating station was seriously delayed, and for some time prevented the opening of the Chesterton and Silverdale lines. It should also be noted that during a large part of the year only a part of the total system has been in operation.

Capital Account.—During the past year the directors have issued £125,000 4½ per cent. debenture stock, part of a total issue of £200,000. This issue has been guaranteed as regards principal, interest, and premium by the British Electric Traction Company, and the expenses of the issue were paid by that company in consideration of this company giving them an option to subscribe for the remaining £75,000 debenture stock at par before April 27th, 1901. The total capital expenditure at December 31st, 1900, was £763,621 3s. 5d. in addition to £186,311, the cost of the debentures and shares held by this company in the North Staffordshire Tramways Company, Limited. At the date of the map accompanying the last report, about 12½ miles of tramways and light railways had been opened for traffic; since then the following sections have been opened at the dates mentioned:—

Hanley to Etruria	1 m. 1 fur. ..	February 2nd, 1900.
Tunstall and Longport ..	0 „ 6 „ ..	March 5th, 1900.
Burslem to Goldenhill ..	2 „ 8 „ ..	March 7th, 1900.
Etruria and Newcastle ..	1 „ 7 „ ..	March 17th, 1900.
Wolstanton to Newcastle..	1 „ 1 „ ..	Do.
Longton to Dresden ..	1 „ 2 „ ..	June 3rd, 1900.
Longton to Normacot ..	1 „ 2 „ ..	July 16th, 1900.
Newcastle to Chesterton ..	2 „ 4 „ ..	January 1st, 1901.
Newcastle to Silverdale ..	3 „ 0 „ ..	Do.

The whole of the tramways and light railways of this company and of the North Staffordshire Tramways Company are now working by electricity, with the exception of the terminal section at Blythebridge, the construction of which is now in hand.

In view of the extensions which have been applied for and of other developments of the business, the directors recommend that power be taken to increase the nominal capital of the company by the creation of 10,000 ordinary shares and 10,000 5 per cent. cumulative preference shares of £10 each, and the necessary resolution which the shareholders will be asked to consider, and, if deemed advisable, to pass, will be found on the first page of the notice convening the meeting.

General.—The directors have applied to the Light Railway Commissioners for an Order to extend the lines of the company along the routes indicated on the accompanying plan. The local enquiry in respect of this application was held on February 21st last, and the Commissioners decided to recommend the Board of Trade to grant the Order. The directors have taken steps to introduce a service for the conveyance of goods and parcels by electric cars over the company's entire system, supplemented by horse and hand vehicles, for the purpose of local distribution throughout the Potteries district, and they hope that this service will be in operation before the summer. The directors have decided to establish an experimental service of steam omnibuses in order to provide traffic facilities for the outlying villages, and two of these conveyances will shortly be run between Burslem and Milton, a distance of about three miles. If the experiment gives satisfactory results, the directors propose to extend the system in other outlying parts of the Potteries district. The directors are in negotiation with some of the local authorities for the transfer to this company of their Electric Lighting Orders. The directors propose to take the opportunity of the general meeting to ask the shareholders to alter the articles of association in accordance with the requirements of the Companies' Act, 1900.

The directors retiring are Mr. C. S. Drummond and Mr. J. V. Kitchener, who are eligible for re-election. Messrs. Bourner, Bullock & Co., the auditors, also retire, and offer themselves for re-election.

	M.	F.	C.
Miles open (December 31st, 1900):—			
Route miles	23	0	1
Single line 17 6 0			
Double line 5 2 1			
Number of passengers carried	9,841,466		
Average receipts per passenger	1·32d.		
Average expenditure per passenger	·83d.		
Proportion of expenses to receipts	62 p.c.		
Number of cars in stock	78		

The annual meeting is to be held at Cannon Street Hotel on Tuesday, March 19th. A special meeting follows for altering the articles.

Northallerton Electric Light and Power Company.

ON Wednesday last week, the first annual meeting was held. The report showed an adverse balance of £473. A great part of this loss was caused by the high price of coal, and a further loss occurred during the earlier period of the year, when the business had not developed, and during the year the current taken by the private consumers had so greatly increased as to necessitate large extensions and alterations. These alterations were almost completed, and while adding greatly to the efficiency of the supply would reduce the cost of production. For the last quarter the business had been very satisfactory, so far as private consumers are concerned. It is estimated that the consumption for private lighting and motors for the next quarter will be over 10,000 units. The contract with the Urban District Council had proved a heavy loss to the company, and the directors felt it their duty to give notice to the council to terminate it in May next. The directors had no wish to make an exorbitant profit out of the public lighting, but they did not feel justified in supplying it at a considerable loss to the company. The directors will be ready to renew the contract on equitable terms, and hope they may be able to do so. The directors had been greatly hampered by the want of sufficient capital to meet the necessary extensions of plant. The shares and debentures which were issued were not taken up by the public. They had, therefore, themselves or through their friends, taken up the quantity of debentures necessary for present needs.

The report was adopted on the motion of Mr. Ringrose, who presided.

Stock Exchange Notices.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in—Baker Street and Waterloo Railway—34,601 ordinary shares of £10 each, £6 paid, Nos. 1 to 34,601, and 66,000 4 per cent. preference shares of £10 each, £6 paid, Nos. 1 to 66,000; Johnson-Lundell Electric Traction Company, Limited—37,398 shares of £5 each, £3 paid. The Committee has appointed a special settling day as under:—Thursday, March 21st—Electric and General Investment Company, Limited—19,900 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 20,101 to 40,000; and has ordered same to be officially quoted.

Prospectus.—The list closed yesterday of applications for an issue of 46,000 £3 shares in Crompton & Co., Limited. The issue price was £3 5s. per share. The prospectus stated that the orders at present on the books are in excess of those filed at any previous period, and notwithstanding the additions made to the Chelmsford works during the past year, further extensions are required to meet the rapid growth of the business. It is for these extensions that this new capital is required.

London United Tramways, Limited.—The directors have determined, after providing for interest on debentures and debenture stock and dividend on the preference shares, to recommend a final dividend on the ordinary shares at the rate of 10 per cent. per annum for the half-year ending December 31st last, the interim dividend to June 30th having been at the same rate. The reserve funds will be increased from £36,190 to £39,467.

Imperial Tramways Company, Limited. — The accounts of this company for the year ending December 31st, 1900, will enable the directors, after payment of interest on the 4½ per cent. debenture stock and dividend at 6 per cent. on the preference capital, to recommend a final dividend for the half-year on the ordinary shares at the rate of 8½ per cent. per annum, making, with the interim dividend paid to June 30th, 8 per cent. for the whole year. The reserve fund will also be increased from £69,203 to £72,789.

Commercial Cable Company.—A quarterly dividend of 1¾ per cent. on the capital stock is payable on April 1st. The accounts for the year 1900 show that after transferring $150,000 to reserve for insurance of stations, apparatus and repair steamer, and $350,000 to the general reserve fund, the profit, including $228,063 brought forward, was $2,007,730. Payment of debenture interest absorbed $720,000, and dividends amounting to 8 per cent. have been declared and paid, leaving $221,066 to be carried forward.

The Brush Electrical Engineering Company.—The directors have decided, after placing £5,000 to reserve, to recommend payment of a dividend on the preference shares of 6 per cent. per annum for the half-year ended December 31st, 1900 (making 6 per cent. for the year), and 5 per cent. on the ordinary shares for the year.

City of London Electric Lighting Company.—The *Westminster Gazette* says that the 1900 report does not allow of any dividend for the ordinary shareholders, and carries forward only £11,343. The meeting will be held next Thursday.

Gateshead Electric and Mechanical Supply Company.—To enable it to provide for the extension of business, it has been decided to increase the capital of the above company to £10,000, in shares of £1 each. It is not at present intended to offer more than a small proportion of the additional capital for public subscription.

Direct Spanish Telegraph Company.—The board has decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, a dividend at the rate of 4 per cent., free of income-tax, on the ordinary shares, both for the half-year ended December 31st, 1900, and payable on April 1st, next.

Oldham, Ashton and Hyde Electric Tramway.—The transfer books and register of members of the ordinary shares will be closed from 13th to 31st inst., inclusive.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending March 8th were £414 16s. 0d.; corresponding week last year, £382 4s. 11d.; increase, £32 11s. 1d. Total to date, £3,808 12s. 4d.; corresponding period last year, £3,431 7s. 7d; increase, £377 4s. 9d. Miles open, 8¼.

Blackpool and Fleetwood Tramways.—The receipts for the week ending March 9th were £166; corresponding week last year £182; decrease, £16. Total to date, £1,394; corresponding period last year, £1,472; decrease, £78.

Bristol Tramways and Carriage Company.—The receipts for the week ending March 8th were £3,753 7s. 5d.; corresponding period last year, £2,569 6s. 8d.; increase, £1,184 0s. 9d.

Central London Railway.—The receipts for the week ending March 9th, were £5,855; previous week, £6,028; decrease, £173. Total receipts to date (10 weeks), £60,662. Miles open, 6.

City and South London Railway.—The receipts for the week ending March 10th were £2,060; corresponding week last year, £1,303; increase, (Moorgate extension open) £757. Total to date, £20,133; corresponding period last year, £11,775; increase, £8,358. Miles open, 1901, 4¾; 1900, 3¾.

Dover Corporation Tramways.—The receipts for the week ending March 9th were £159 13s. 3d.; corresponding week last year, £141 10s. 8½d.; increase, £18 2s. 6½d. Total to date, £1,533 6s. 7d.; corresponding period last year, £1,451 8s. 3½d.; increase, £81 18s. 3½d. Miles of track open, 3; Car miles run, 1901, 4,934; 1900, 4,599. Number of cars, 11.

Dublin United Tramways Company.—The receipts for the week ending March 8th were as follows:—D. U. T. Co., electric cars, £3,154 2s. 4d.; D. S. D. Co., electric cars, £647 6s. 11d.; total £3,801 9s. 3d.; corresponding week last year—D. U. T. Co., electric cars, £2,784 6s. 1d.; ditto, horse cars, £46 18s. 11d.; D. S. D. Co., electric cars, £643 6s. 3d.; total, £3,474 11s. 3d.; increase, £326 18s. 0d.; aggregate to date, £36,265 2s. 8d.; aggregate to date last year, £33,275 3s. 4d.; increase, £2,989 19s. 4d. The mileage worked is 45 miles electrically, as against 42 miles electrically, 2 miles by horses, for the corresponding period last year.

Liverpool Overhead Railway.—The receipts for the week ending March 10th were £1,507; corresponding week last year, £1,369; increase, £138. Total to date, £14,695; corresponding period last year, £14,301; increase, £394. Miles open, 6 miles 57 chains.

STOCKS AND SHARES.

Wednesday Evening.

The attention of investors and speculators alike is now turned more eagerly than ever towards South Africa. Whilst negotiations are proceeding between the two generals, markets hold their breath, and the only business done is on account of professionals who are prepared to back their foresight in a practical way. The absence of any definite news respecting peace prospects up to to-night has checked business in all departments. Conclusion of the war means cheapening of money, which still continues dear, as those who are carrying over electrical securities of any class have had renewed experience this week. The only stocks and shares quoted in our lists which command a large speculative following are Central London Rails and Anglo-American Telegraph Deferred stock, on both of which a stiff rate ruled at the carry-over last Tuesday.

The outstanding feature of the week in electrical or kindred markets is a sharp fall of nearly 4 per cent. in the price of Metropolitan Railway Consolidated Stock, which now stands no higher than 75, the lowest figure it has touched for many years. The reason advanced for the decline is that proprietors of the stock are growing nervous at the apparent hanging fire of the electrification proposals, and that they have been selling stock very freely. Metropolitan District Ordinary is also weaker at 27¼—this in sympathy with the drop in Metropolitans.

We suppose it is hopeless to expect to get any truthful news concerning the Baker Street and Waterloo Railway, the shares of which are all but unsaleable. The latest rumour has it that an American syndicate, which possesses an option over the property, intends to exercise its privilege, but rumour addeth not the price that is to be paid. There is some vague talk of a Yankee company, with a capital of £3,000,000 sterling, taking the concern in hand. For the sake of the unhappy London and Globe shareholders, we hope, rather than believe, that the rumour is correct.

Electricity supply shares continue a steady market without exhibiting any great change. County of London and Brush shares were marked down £1, but recovered half the fall. The dullness is induced by anticipations concerning the demand. Citys have advanced £1, regaining the level which they occupied before the passing of the dividend was made known, and this in spite of the wretchedly bad report just out. Chelseas fail to recover their recent decline, although the meeting was a satisfactory one. The chairman stated that the company would have to invest a substantial sum before the end of the year in compulsorily acquiring certain lands and properties for the purpose of its business. These remarks, it is suggested, may possibly be taken to foreshadow a fresh appeal for capital. Metropolitans are still weak; the new shares, £5 paid, are worth £7 10s. Beyond these there are no remarkable changes in price. The Stock Exchange seems to be watching with considerable interest Sir Courtenay Boyle's inquiry regarding the proposed alterations in voltage, and at present nobody seems quite to know what effect upon dividends—and therefore upon quotations—the matter is likely to have.

In the telegraph market the noteworthy changes are confined to declensions in Anglo-American Preferred and Deferred securities, the market sagging away on the appearance of a few speculative sellers. Eastern Extension Debenture stock is finding supporters, and a very small purchase was sufficient to raise the price a point. No fluctuation has occurred in the shares, nor in Eastern Ordinary stock. Mr. Chamberlain's declaration in the House of Commons that a formal agreement had not been signed between His Majesty's Government and the two Eastern Companies in regard to the all-British cable was passed over as a matter not affecting the market.

Telephone descriptions exhibit the regular fall, National Ordinary being ½ down, and the 3½ per cent. Debenture stock losing 2 per cent.

A good many bargains are being booked in London United Tramways 4 per cent. Debenture stock, now quoted at 102. In the report, out this week, the directors are recommending a final dividend on the Ordinary shares at the rate of 10 per cent. per annum. This is 1½ per cent. better than the dividend to be paid on Imperial Tramways shares. The latter are obtainable at 17½, and our readers need no reminder that the Imperial Tramways owns a very large interest in the London United Company. Another tramways company, whose shares have lately been added to the Official List of the Stock Exchange, is the Cape Electric. The £1 shares are quoted 1¾ to 2, and the achievements of the board have been excellent since the company started work four years ago. Of course, its more recent and striking prosperity is due to the war, and if the plague should really become serious at Cape Town, the current half-year's results may fall off, as compared with the first six months of 1900, but the concern is well managed, and commands a fine field for its enterprise.

Cromptons are making a new issue of shares in order to provide money for the extension of their business. The prospectus contains the remarkable declaration that the directors may proceed to allotment upon applications amounting to £100. This clause is, of course, inserted in order to comply with the requirements of the new Companies' Act (1900), but it seems a pity that a first-class concern such as Cromptons is, should set what can only be regarded as a bad example.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation March 6th.	Closing Quotations March 13th.	Business done during week ended March 13th, 1901. Highest.	Lowest.
96,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —102	99 —102	...	...
119,700	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	55 — 65	55 — 65	...	...
822,700	Anglo-American Telegraph	Stock	£3 9s.	73/6	3⅛%	51 — 54	51 — 54	52	50½
3,088,540	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	96 — 98	95 — 97	97	95
3,088,540	Do. do. Deferred	Stock	18s. %	£1 7s.	5s.%	8½— 9	8¼— 8¾	8⅝	8 7/16
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	...	3 — 3½	3 — 3½	...	...
13,333,300$	Commercial Cable	$100	8 %	8 %	...	165 —175	165 —175	...	...
1,589,496£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	102 —104	102 —104	102½	102¼
16,000	Cuba Telegraph	10	8 %	7 %	...	7½— 8½	7½— 8½	...	...
6,000	Do. 10 % Pref.	10	10 %	...	...	16 — 17	16 — 17	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	100 —104%	100 — 104%	...	...
60,710£	Direct United States Cable	20	3½%	3 %	3 %	9⅜— 10¼	9⅜— 10¼	10	9⅜
108,300	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	144 —149	144 —149	146	144
1,826,888	Do. 3½ % Pref. Stock	100	...	...	...	94 — 97	94 — 97	95¾	94⅜
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	113 —117	113 —117	115	113
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	...	14¼— 14⅜	14¼— 14⅜	14 11/16	14⅜
50,000	Do. Nos. 250,001 to 300,000 (iss. at £3 pm. all pd.) ...	10	...	...	...	13⅜— 14¼	13⅜— 14¼	14	13⅞
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	110 —115	111 —116	113	110
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	99 —102	99 —102	100	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	101 —104%	101 —104%	...	...
180,227	Globe Telegraph and Trust	10	5⅛%	5¼%	...	9⅜— 10¼	9⅜— 10¼	10 1/16	9⅜
180,042	Do. do. 6 % Pref.	10	6 %	...	...	14⅜— 15¼	14⅜— 15¼	15	14 3/8
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	...	32 — 34	32 — 34	32⅜	...
82,000	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102	99 —102	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	47 — 51	47 — 51	49	47
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	...	...	...	103 —106 xd	103 —106	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	2½%	...	¼— ½	¼— ½	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	5 %	...	½— 1	½— 1	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	5 %	3⅛— 3⅜xd	3¼— 3½	3 7/16	3 3/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 13 xd	11 — 13	11⅛	11⅛
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11 — 13 xd	11 — 13	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4¼— 4½xd	4¼— 4⅜	4 11/16	4½
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	94 — 97	92 — 95	95½	94
500,000	Do. 4 % Deb. Stock Red.	100	...	...	4 %	98 —101	98 —101	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅞— 1⅛	⅞— 1⅛	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	...	...	...	99 —102	99 —102	...	...
11,839	Reuter's	8	5 %	5 %	...	7½— 8½	7½— 8½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	124 —129	124 —129	...	...
58,000	United River Plate Telephone	5	6 %	7 %	...	4½— 5	4½— 5	4⅞	...
40,000	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4⅜— 5¼	4⅜— 5¼	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	103 —106	103 —106	103½	...
171,000	West African Telegraph, 5 % Debs....	100	...	...	...	97 —100 xd	97 —100	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	...	...
150,000	Do. do. 4 % Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	99 —102	99 —102	..	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	13⅜— 14¼	13⅜— 14¼	14⅛	13⅞
75,000	Do do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	101 —104	101 —104	...	...
348,777	Do. do. 4 % Deb. Stock Red.	100	...	...	...	102 —105	102 —105	...	...
88,321	West India and Panama Telegraph	10	2 %	5%	...	⅝— ¾	⅝— ¾	...	..
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	...	...	...	6 — 7	6 — 7	6⅜	6⅛
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	...	...	...	5 — 7	5 — 7	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	103 —106	103 —106	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	6 %	7 — 8	7 — 8	7¾	7 11/16
12,000	Do. do. 7 % Cum. Pref....	5	...	...	...	8 — 9	8 — 9	8 11/16	8 9/16
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	9 %	9½— 10½	9½— 10½	10⅛	9¾
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5½— 5⅝	5½— 5⅝	5½	5 3/16
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	5½%	6 — 6½	6 — 6½	5½	5⅝
150,000	Do. do. do. % Deb. Stock Red. ...	Stock	...	...	...	109 —112	109 —112	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579...	10	6 %	4 %	...	6½— 7½	7½— 8½	8	7¼
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	...	...	13 — 14	13 — 14	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	122 —127	122 —127	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	4 %	...	8 — 9	7½— 8½	8⅛	7¼
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	...	...	11½— 12½	11½— 12½	...	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	106 —109	106 —109	...	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	7 %	...	...	4¾— 5¼	4¾— 5¼	4 15/16	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	103 —106	103 —106	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1½— 2	1½— 2	...	...
49,840	Do. do. do. do. 6 % Pref.	5	6 %	...	...	4 — 5	4 — 5	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	98 —101	98 —101	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	6 %	12½— 13½	12½— 13½	13	...
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	110 —113	110 —113	...	...
250,000	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	96 — 99	96 — 99	98	...
6,452	Notting Hill Electric Lighting	10	6 %	7 %	7 %	15½— 16½	15½— 16½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14 — 15	14 — 15	14⅜	14¼
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½	...	...
150,000	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	98 —101	98 —101	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	2⅛	...
50,000	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2½— 3½	2½— 3½	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000... ...	5	12 %	13 %	10½%	12 — 13 xd	12 — 13	12 11/16	12 3/16

* Subject to Founders Shares.
Unless otherwise stated all shares are fully paid.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.
Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Mar. 6th.	Closing Quotation Mar. 13th.	Business done week ended Mar. 13th, 1901. Highest	Lowest
		‡							
20,000	‖British Aluminium 7 % Cum. Pref.	10	...	...	...	8 — 9	8 — 9	...	...
300,000	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	91 — 95	91 — 95	...	...
45,000	British Electric Traction	10	6 %	...	...	14½— 15½	14 — 15	14⅞	...
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	11½— 12½	11½— 12½	12 5/16	...
350,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	120 —123	120 —123	...	...
85,000£	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	1/16— 3/16	1/16— 3/16	...	...
50,000	† Do do. 6 % Cum.Pref., 1—50,000 ...	...	...	...	...	3/16— 5/16	3/16— 5/16	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	85 — 90	85 — 90	...	...
70,000	British Insulated Wire Ord.	5	15 %	20 %	15 %	10 — 11 xd	11 — 12	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5⅝— 6¼	5⅝— 6¼	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	2	5 %	6 %	...	1⅝— 1⅞	1⅝— 1⅞	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	...	2⅛— 2⅜	2⅛— 2⅜	2 5/16	...
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	103 —108 xd	103 —108	...	...
108,710	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	101 —103	101 —103	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	...	15 — 16	15 — 16	15 1/16	15⅛
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½— 6	5½— 6	5 1/16	5½
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	109 —113	109 —113	...	...
206,297	Central London Railway, Ord. Shares	10	...	...	...	9 — 9¼	8¾— 9¼	9¼	9
78,703	Do. do. Pref. half-shares	5	...	...	...	4¾— 5¼	4¾— 5¼	5	...
78,703	Do. do. Def. do.	5	...	...	...	4 — 4½	4 — 4½	...	...
855,000	City and South London Railway	Stock	2½%	1⅞%	1½%	46 — 50	46 — 50	48½	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000	10	...	...	...	4 — 5	4 — 5	...	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	6 %	7½%	...	3½— 3¾	3½— 3¾	...	...
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	100 —103	100 —103	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	...	1½— 2 xd	1½— 2	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	...	3½— 4¼xd	3½— 4¼	...	...
344,023	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	88 — 90	88 — 90	89	...
100,000	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	96 —100	96 —100	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	1⅞— 2¼	1⅞— 2¼	2 1/16	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	...	...	2½— 3	2½— 3	...	...
182,500	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	101 —104	101 —104	...	...
9,600£	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600	10	7 %	7 %	...	10 — 11	10 — 11	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	14 %	15 %	20 %	16 — 17	16 — 17	16⅝	...
35,000	Do. do. do. 4½ % Pref.	5	7 %	...	...	5½— 6	5½— 6	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	107 —111 xd	107 —111	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	20½— 21½	21 — 22	21¼	21⅛
300,000	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	102 —105	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3⅝%	3¼%	7⅞ — 8	7⅞— 8¼	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5	...	13 — 13¼	13 — 13¼	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	17½%	38 — 42	38 — 42	40½	39½
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	101 —104	101 —104	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	8 %	12 %	...	11 — 12	11 — 12	11	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5½— 6	5½— 6	...	...
540,000£	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	93 — 96	93 — 96	96	94½

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Brompton and Kensington, 4½ % Debentures of £100, 101—104.
Consolidated Telephone Construction and Maintenance, 3/—4/-
National Electric Free Wiring, 12/6 paid, ⅞—1⅛.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 15½—16½.
Do. do. Pref. (£10 pd.), 10—10½.
* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 11—12; 1st Preference Cumulative 6 % £5 (fully paid), 6½—7 Debentures, 101—104. Dividend, 1900, on Ordinary Shares 12 %.
*T. Parker, £10 (fully paid), 16½.

Bank rate of discount 4 per cent. (February 21st, 1901).

MARKET QUOTATIONS, Wednesday, March 13th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a ,, ,, ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£17 10	£17 10	..
a Bensole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90%)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£25	£25	..
a Lead, Nitrate	per ton	£25	£25	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160°C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	5½d.	5½d.	..
a ,, Caustic (75/80%) ..	per ton	£24	£24	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	64/-	64/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6 5s.	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
,, Bichromate, casks ..	per lb.	2¾d.	2¾d.	..

METALS, &c.				
b Aluminium Wire, in ton lots..	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£80 to £145	£80 to £145	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	7¾d.	..
c ,, Tube (brazed)	per lb.	10d.	10d.	..
c ,, ,, (solid drawn) ..	per lb.	8¾d.	8¾d.	..
c ,, Wire, basis	per lb.	8¾d.	8¾d.	..
c Copper Tubes (brazed)	per lb.	11d.	11d.	..
c ,, ,, (solid drawn) ..	per lb.	10¾d.	10¾d.	..
g Copper Bars (best selected) ..	per ton	£85 10	£86	10s. dec.

METALS, &c. *(continued.)*		This week	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£85 10	£86	10s. dec.
g ,, Rod	per ton	£85 10	£86	10s. dec.
c ,, (Electrolytic) Bars ..	per ton	£82	£82	..
c ,, ,, Sheets ..	per ton	£90	£90	..
c ,, ,, Rod ..	per ton	£84	£84	..
c ,, ,, H.C. Wire	per lb.	9½d.	9½d.	..
f Ebonite Rod	per lb.	3/-	3/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/6½ to 3/7	3/6½	inc.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants) ..	per ton	46/2	45/9	5d. inc.
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire, galvanised No. 8 ..	per ton	£10	£10 5	5s. dec.
g Lead, English Ingot	per ton	£13 10	£13 15 to £13 17 6	5s. dec.
g ,, ,, Sheet	per ton	£17 15	£17 15	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9 2 6	£9 2 6	..
d Mica (in original cases), small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large ..	per lb.	3/3 to 7/8	3/3 to 7/8	..
p Phosphor Bronze, plain castings	per lb.	1/0½ to 1/3	1/0½ to 1/3	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£4	£4	..
p Silicium Bronze Wire	per lb.	10½d. to 1/½	10½d. to 1/1	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	From £40	..
i ,, ,, in bars		£58	£58	..
g Tin, block	per ton	£121 10 to £122 10	£124 to £125	50s. dec.
g ,, foil	per lb.	1/6	1/6	..
n ,, wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals — "White Ant" brand	per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10 lb. b'ndl's	per lb.	9½d.	9½d.	..
j ,, Best Flax, 6 lea.	per lb.	6d.	6d.	..
j ,, Hemp, 3 ply 10 lbs. ..	per lb.	4¾d.	4¾d.	..
j ,, ,, Russian, 10 lbs. ..	per lb.	5¾d.	5¾d.	..
j ,, Jute, 180 lbs. rove ..	per ton	£14 10	£14 10	..
k Zinc, Sh't. (Vielle Montagne ord.)	per ton	£21	£21 12 6	12s. 6d. dec.

Quotations supplied by { a Messrs. G. Boor & Co. b The British Aluminium Co., Ltd. c Messrs. Thos. Bolton & Sons. d Messrs. F. Wiggins & Sons. e Messrs. Frederick Smith & Co.

Quotations supplied by { f India-Rubber, G.-P. and Teleg. Works Co., Ltd. g Messrs. James & Shakspeare. h Messrs. Jackson & Till. i Messrs. Boiling & Lowe. j Messrs. Henry C. Yee & Co.

Quotations supplied by { k Messrs. Morris Ashby, Limited m Messrs. W. T. Glover & Co., Ltd. n Messrs. P. Ormiston & Sons. o Messrs. Johnson, Matthey & Co., Ltd. p The Phosphor Bronze Company, Ltd.

INSTITUTION OF ELECTRICAL ENGINEERS (GLASGOW SECTION).

A METHOD OF COMPENSATING VOLTMETERS FOR THE VOLTAGE DROP IN LONG FEEDERS.

By Michael B. Field, A.M.I.C.E.

Paper read February 13th, 1901.

(*Concluded from page* 430.)

Analytical Investigation.

A simple and straightforward, though possibly a somewhat lengthy, method of dealing with this subject is to consider n feeder circuits (fig. 11), where F_1, F_2, F_n, &c., represent the total (go and

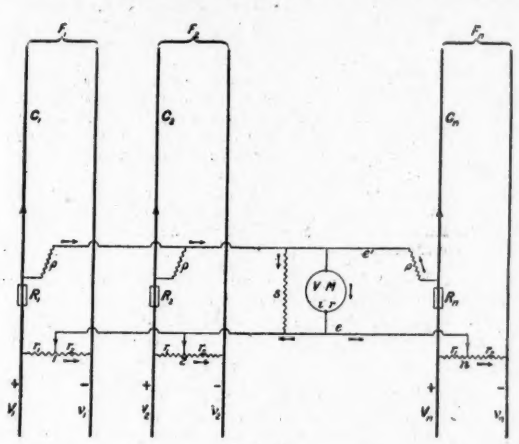


Fig. 11.

return) feeder resistances of the various circuits. At the station end the positive and negative feeders of each circuit are bridged over by resistances $r_1 + r_2$, and all the points, 1, 2, 3, &c., of these resistances are connected together and to one terminal of the volt-

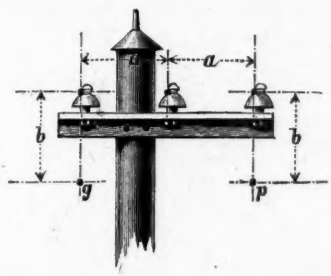


Fig. 12.

meter. The potential of this terminal is e. The resistance of the voltmeter is r, and the current flowing through it i. It is further shunted by a resistance s.

Let v_1 v_1, v_2 v_2, &c., be the potentials of the positive and negative feeders of the different circuits respectively, then it is easy to show that—

$$e = \frac{r_2}{r_1 + r_2} \cdot \frac{\Sigma (v_1 + v_2 + \ldots v_n)}{n} + \frac{r_1}{r_1 + r_2} \cdot \frac{\Sigma (v_1 + v_2 + \ldots v_n)}{n} + \frac{r_1 r_2}{r_1 + r_2} \cdot \frac{s + r}{s} \cdot \frac{i}{n} \qquad (1)$$

Let R_1, R_2, . . . R_n be the series resistances inserted in the feeder circuits, and let the far end of each of these be connected by a wire whose resistance is ρ to the second terminal of the voltmeter. Calling the potential of this terminal e', we may write—

$$e' = \frac{\Sigma (v_1 + v_2 \ldots v_n)}{n} - \frac{\Sigma (C_1 R_1 + C_2 R_2 \ldots C_n R_n)}{n} - \rho \cdot \frac{s + r}{s} \cdot \frac{i}{n} \qquad (2)$$

where C_1, C_2, . . . C_n are the various feeder currents, which may be taken as identical with the currents flowing through R_1, R_2, &c., provided ρ be sufficiently large to prevent any appreciable interchange of current between the various feeders.

We have further—

$$e' - e = i r \qquad (3)$$

Hence, eliminating e and e' we have—

$$i = \frac{\frac{1}{n} \Sigma \left(v_k - v_k - \frac{r_1 + r_2}{r_1} \cdot C_k R_k \right)}{\left(\rho \cdot \frac{r_1 + r_2}{r_1} + r_2 \right) \frac{s + r}{s n} + r \left(\frac{r_1 + r_2}{r_1} \right)} \qquad (4)$$

If $\frac{r_1 + r_2}{r_1} = \frac{R_1 + F_1}{R_1} = \frac{R_2 + F_2}{R_2} = \&c.,$

the numerator of the above expression is merely the average voltage existing at the far ends of all the feeder circuits. We will call this v_a. It is then clear that the current flowing through the voltmeter is proportional to v_a if any given number of feeder circuits be connected. The constant of the instrument, however, involves n; in order therefore to make the same calibration serve for all values of n, and to obtain the most sensitive arrangement, we must keep $\frac{s + r}{s n}$ equal to unity, in other words, s must always equal $\frac{r}{n - 1}$. This therefore is the function of the shunt s in fig. 2, and if by means of the multiple contact switch, s be made to depend on n in the above manner, we have—

$$i = \frac{v_a}{r_2 + \frac{(\rho + r)(r_1 + r_2)}{r_1}}$$

If $n = 1$ we may make $\rho = o$ and $s = \infty$, *i.e.*, no shunt is required. This is the arrangement of Crompton and Ashley, and also of Heap.

The equation holding for the device represented in fig. 1 is slightly different from the foregoing:—

We must insert in equation (1)

$$n = 1, v = \frac{1}{n} \Sigma (v_1 + v_2 \ldots v_n), \quad o = \frac{1}{n} \Sigma (v_1 + v_2 + \ldots v_n)$$

and in equation (2) merely

$$v = \frac{1}{n} \Sigma (v_1 + v_2 \ldots v_n)$$

Combining (1) and (2), we have—

$$i = \frac{v_a}{\left(\frac{\rho}{n} \cdot \frac{r_1 + r_2}{r_1} + r_2 \right) \frac{s + r}{s} + \frac{r (r_1 + r_2)}{r_1}}$$

Now in this case, if ρ be very small compared with r, we may say that i does not depend on n, hence s may be made ∞, *i.e.*, no shunt is required, and we have—

$$i = \frac{v_a}{r_2 + \frac{r (r_1 + r_2)}{r_1}}$$

Applying the above results to an actual case, let $v = 200$, and let the current required by the voltmeter for maximum scale deflection, corresponding to (say) 220 volts, be 0·01 ampere, the resistance of the voltmeter being 60 ohms.

Let, further—

$$\frac{F_1}{R_1} = \frac{F_2}{R_2} = \&c. = 99,$$

then we have—

$r_2 = 16{,}000$ ohms.
$r_1 = 161{\cdot}6$ „

We may take it that the maximum feeder drop will not exceed 10 per cent., hence the maximum volt drop along R_1, R_2, &c., cannot be greater than 0·2 volt. If, therefore, $\rho = 0{\cdot}75$ ohm, we may say that the interchange of current between any two feeders cannot be more than 0·13 ampere, or an amount which is quite inappreciable, and at the same time the maximum error introduced by the variation of the value of $\frac{\rho}{n}$ as n is varied cannot exceed $\frac{1}{4}$th of one per cent.

With the arrangement shown in fig. 2, ρ must be much greater than heretofore assumed, for if one set of feeders be switched out, the voltage at the near end of the positive of the same might differ by as much as 20 volts from that of neighbouring positive feeders, and a serious interchange of current between them would occur if ρ were not of considerable magnitude. Since, however, from equation 4 it appears that no error whatever is produced by the variation of n, provided s is always equal to $\frac{r}{n - 1}$, we may, if we like, take $\rho = 100$ ohms. In this case, taking the same constants for the voltmeter as before, r_2 will come out 6,000 ohms and r_1 60·6 ohms.

It has been assumed throughout the foregoing that the same current returns by the negative feeder as goes by the positive feeder of the same circuit; this will generally be true, unless, indeed, the resistances of the positive and negative feeders are different, or the problem is complicated by the fact that there are faults at different parts of the system. In such cases, however, where the outgoing current is of *different magnitude* from the return current, the following arrangement might be employed, which moreover is particularly applicable to three-wire systems and such like:

To derive an expression for i in case (b)—see fig. 5—we have from equation (1)—

$$e = \frac{r_2}{r_1 + r_2} \cdot \frac{\Sigma\, v_\kappa}{n} + \frac{r_1}{r_1 + r_2} \cdot \frac{\Sigma\, v_\kappa \pm C'_\kappa B'_\kappa}{n} + \frac{r_1 r_2}{r_1 + r_2} \cdot \frac{s + r}{s} \cdot \frac{i}{n} \qquad (5)$$

To obtain e' we must substitute in this same equation—

e'	for	e	$v_\kappa - C_\kappa R_\kappa$	for	v_κ
r_4	„	r_1	v_κ	„	$v_\kappa \pm C'_\kappa B'_\kappa$
r_3	„	r_2	$-i$	„	i

and we may further write $r_1 + r_2 = r_3 + r_4$,

hence—

$$e' = \frac{r_3}{r_1 + r_2} \cdot \frac{\Sigma\, v_\kappa - C_\kappa R_\kappa}{n} + \frac{r_4}{r_1 + r_2} \cdot \frac{\Sigma\, v_\kappa}{n} - \frac{r_3 r_4}{r_1 + r_2} \cdot \frac{s + r}{s} \cdot \frac{i}{n}. \qquad (6)$$

Combining (3), (5), and (6) we get—

$$i = \frac{\frac{i}{n}\, \Sigma \left(v_\kappa - v_\kappa - C_\kappa\, (R_\kappa + F_\kappa) \mp C'_\kappa\, (R'_\kappa + F'_\kappa) \right)}{(p\, r_4 + q\, r_2) \frac{s + r}{s\, n} + \frac{r\, (r_1 + r_2)}{r_3 - r_2}}. \qquad (7)$$

where

$$\frac{r_3}{r_3 - r_2} = 1 + \frac{F_1}{R_1} = 1 + \frac{F_2}{R_2} = \&c. = p,$$

and

$$\frac{r_1}{r_3 - r_2} = 1 + \frac{F_1'}{R_1'} = 1 + \frac{F_2'}{R_2'} = \&c. = q.$$

Now the numerator in (7) is the average voltage obtaining at all the far ends of the feeder circuits between the outers F_1, F_2, &c., and the neutrals F_1', F_2', &c. Call this average voltage, as before, V_a.

If, then, we again, by means of the multiple contact switch, keep $\frac{s + r}{s\, n}$ equal to unity, we have for case (b)—

$$i = \frac{V_a}{p\, r_4 + q\, r_2 + \frac{r\, (r_1 + r_2)}{r_3 - r_2}},$$

from which the necessary values for r_1, r_2, r_3, and r_4, are calculable for any given instance.

The last case is that of (c), fig. 10. We can readily derive the equation for the voltmeter (which may be designated v') from equation (4), by writing:—

$n = 1$	$R + l\,\theta$ for R_1	$\frac{1}{r_2\,\theta}$ for r_2
$s = \infty$		
$\rho = 0$	$\frac{1}{k_1\,\theta}$ „ r_1	$\frac{1}{\kappa\,\theta}$ „ r;
$v = 0$		

where R and l are the resistance and self-induction respectively of that portion of the line spanned by the pilot-wire, κ is the capacity of the voltmeter, this being a function of the position of the movable vanes, and θ represents the operator $\frac{d}{d\,t}$.

We have then—

$$v' = \frac{i}{\kappa\,\theta} = \frac{V - \frac{k_1 + k_2}{k_2} \cdot (R + l\,\theta\, C)}{\frac{\kappa + k_1 + k_2}{k_2}}.$$

If—

$$\frac{k_1 + k_2}{k_2} = \frac{F}{R} = \frac{L}{l},$$

the numerator of the above expression represents the voltage obtaining at the end of the line. Call this v_e.

As already explained, k_2 may advantageously be made about equal to the maximum value of κ, in which case, owing to the comparatively large value of k_1, we may write with great accuracy—

$$v' = \frac{k_2}{k_1 + k_2}\, V_e.$$

It has been pointed out in the previous part of this paper that it is necessary to shield the pilot-wire from the inductive action of the line.

If the line be a single-phase one carried overhead, it will be simple to place the pilot-wire symmetrically with regard to the two line wires, in which case all inductive effects will be obviated.

If the line be an overhead three-phase one, it is not always possible to place the pilot wire in a symmetrical position with regard to all three line wires. The inductive action may, however, be neutralised by running the pilot wire for *part* of the distance nearer the one or other of the lines. Thus, if the three line wires be carried in a row (see fig. 12) and a pilot wire be run for a total distance of 500 yards from the station, it might be located for 250 yards in position p, and for the remaining 250 yards in position q. The inductive action of each line wire on the pilot wire depends on the logarithm of the reciprocal of the distance between them plus a constant, which latter is the same for all the line wires.

If, therefore, we adjust matters so that

$$\frac{1}{2} \log. \left(\frac{1}{b}\right) + \frac{1}{2} \log. \left(\frac{1}{\sqrt{4\,a^2 + b^2}}\right) = \log. \left(\frac{1}{\sqrt{a^2 + b_2}}\right),$$

or

$$b = \frac{1}{\sqrt{2}}\, a,$$

the inductive action of each line wire on the pilot wire will be the same, and since the total current flowing in the three line wires at every instant is zero, the total inductive effect will likewise be zero.

With other arrangements of the line wires, corresponding modifications of the positions of the pilot wire will be requisite.

A meeting of the Glasgow Section of the Institution was held on 13th inst. in the large Hall of the Institution of Engineers and Shipbuilders in Scotland, 207, Bath Street. The chair was taken by Prof. Magnus McLean, in the absence of the President, Lord Kelvin, who was unavoidably detained in London. Before proceeding to the business of the evening, the chairman mentioned that this was the first meeting since the nation was thrown into mourning by the lamented death of the late Queen, and he stated that the Council had had a special meeting and passed resolutions of condolence on behalf of the Section, which had been forwarded to the Home Secretary; he asked the present meeting to confirm the resolutions so passed, which were "that this special meeting of the committee, on behalf of the Glasgow Local Section of the Institution of Electrical Engineers, desires to express its deep sense of the loss sustained by the death of their late beloved Sovereign Queen Victoria, whose long beneficent reign has been marked by such social and scientific progress." It was further resolved "that an expression of confidence and loyalty be sent to His Most Gracious Majesty King Edward, with the hope that he might long be spared to reign over an attached people."

Abstract of Discussion on Mr. Field's Paper.

Prof. A. Jamieson said:—The chief object which Mr. Field had in view was to ascertain the drop in pressure along live feeders without using pilot wires, and he puts down the first cost of twin pilot wires at £90 per mile. I think that this may be taken as a maximum value, since the trenches must be opened for the feeder troughs or pipes, whether pilot wires are put down or omitted. There is one disadvantage which Mr. Field's system has when compared with the use of pilot wires, viz., their employment (if sound) in localising faults in the feeders by means of "loop tests." Moreover, he introduces a constant loss of power by the permanent insertion of the series resistances R_1, R_2, R_3, &c. (see figs. 1, 2, &c.), unless he can employ them as the feeder "fuse wires," or for the lightning protector coils, or for the automatic switch coils. For example, suppose the current conveyed by these several resistances to be 1,000 amperes, with a difference of potential between the ends of only 0·2 volt (as assumed in the paper), then the continuous loss of power will be 200 watts for each inserted resistance. This quantity, when added to the losses ($r_1 + r_2$), may thus amount to about ⅓-H.P. The annual value of this loss would go far to pay interest and depreciation upon ordinary pilot wires. Mr. Field's ingenious methods of obtaining the average voltage at the ends of a group of feeders may no doubt satisfy the Board of Trade authorities, who demand statements of such averages in the station log sheets, but great care must be taken that switchboard attendants do not place too much reliance upon them. One consumer or district may be supplied at 10 per cent. more than the normal voltage, whilst another is receiving 10 per cent. less than the normal, and yet the mean voltage coincides with the normal. The method (see fig. 1) of ascertaining the voltage at the far end of a line of known resistance, by taking the potential difference between the ends of another known resistance placed in circuit with the former at its home end, is not new. I have frequently used this test since 1872, and I believe that this method was first devised by Mr. Latimer Clark, and improved upon by Prof. Fleeming Jenkin.* Fig. 2 is, however, new to me for obtaining averages, and I have much pleasure in congratulating Mr. Field upon his devices, and their explanations as illustrated by figs. 4, 5, 6 and 10. The latter is especially neat and interesting, although the substitution of condensers for resistances is by no means new. Their use and interchangeability in the case of the bridge arms of artificial lines for working submarine cables upon the duplex principle has been employed for nearly a quarter of a century. Their application, however, to very high alternate current voltages is one of the ticklish experiments upon which we should have been glad to have had some practical results.

Mr. W. McWhirter said:—Mr. Field has shown us how to carry out an important test in a very elegant, simple, and economical manner. No doubt the great sensibility of the moving coil type of instrument, together with the proportionality of the scale divisions, its supposed extreme constancy and freedom from disturbance by external magnetic fields, have made it many friends; but I would like to call the attention of central station engineers to this—don't take too much for granted about your Weston meters. Don't be sure the scale divisions are strictly proportional. Don't assume the *constancy* of magnetic field, and don't take it for granted that these meters are *not* affected by external magnetic fields. Now that shielded electro-magnetic volt and ammeters are obtainable where less than 2 watts are used upon a circuit of 100 volts, where the temperature coefficient is nil, where the scale error is under 1 per cent., and absolutely constant, and where magnetic field

* See Munro and Jamieson's "Pocket-Book of Electrical Rules and Tables."

errors do not exist, I think such an instrument is worthy further attention, and should not be lightly abandoned. Further, such instruments can be calibrated to read correctly upon either continuous or alternating circuits as required, and are therefore most suitable for use in the arrangement of Hopkinson, which from its simplicity will be very hard to supplant.

Prof. Maclean remarked that the paper was an exceedingly important one from a practical point of view, and he asked Mr. Field (1) to give some relative statements as to the amount of energy wasted in the series resistances R_1, R_2, R_3, &c., and (2) to make it clear, if the resistances R_1, R_2, &c., were not exactly $\frac{1}{n}$th of the feeder resistances, whether or not the voltmeter needed recalibration in the central station.

Mr. Field, in reply, said: Prof. Jamieson seems to think that measuring the "average voltage" over a network is useless. I admit it does not give all the information required, but, by the methods I have described, not only the average, but also the individual feeding point voltages can be determined. In such a case I think that the information obtained *is* of distinct advantage. The price of £90 per mile of twin pilot wire was the actual figure for a two-core paper-insulated lead-covered cable capable of withstanding 1,000 volts between cores, or between cores and lead, and includes drawing in and jointing. It is by no means a high price. Prof. Jamieson tells us that the method I have described for compensating voltmeters as due to Crompton & Ashley did not originate with them. I believe, however, they took out the original patents. An exact regulation of the feeding point voltage on tramway systems is not at all essential. The reference made in the paper to power systems applies to such as include the driving of motors of cotton spinning machinery and such like, where an exact and constant speed is of the utmost importance. Prof. Jamieson remarked that the different temperature coefficients of the series resistances R, R_1, &c., and of the line would produce errors. It is evident, however, that since we are compensating the voltmeter for a quantity of, say, not more than 10 per cent. of the total measurement, a small percentage of this compensation becomes negligible. If we want to be very exact we can dispense with R, R_1, &c., altogether by using a portion of the cable itself and running a pilot wire back, say, from the first junction box along the route. Mr. McWhirter spoke about my preference for Weston instruments. The methods dealt with in the paper are applicable using any type of sensitive instruments without constructional modifications of any kind. Replying to Prof. Maelean, if R, R_1, &c., are not exactly right, no very great error is introduced. The voltmeter readings will merely compensate for the drop in a line a little longer or a little shorter than the actual one. It is not at all necessary to calibrate the instruments *in situ*. A spurious line circuit having the feeder resistance is made up in the laboratory and connected to the instrument, which is easily calibrated under these conditions and the series resistances perfectly adjusted. The series resistances are precisely similar to those supplied with Weston ammeters, and therefore do not involve any greater energy losses than do these ammeters, which are in very common use.

INSTITUTION OF ELECTRICAL ENGINEERS (MANCHESTER SECTION).

ON THE USE OF STORAGE BATTERIES IN CONNECTION WITH ELECTRIC TRAMWAYS.

By G. A. Grindle, M.I.E.E.

(*Abstract of Paper read February 26th*, 1901.)

(*Concluded from page* 404.)

Saving in Operating Plant.—The judicious and adequate employment of accumulators will very materially reduce the amount in construction cost of a generating plant, that is to say, the boilers, engines, and the generators at the power station, and also, in consequence, the cost of station buildings.

If we take a typical load curve of a power station operating an average-sized tramway system in this country, it will be found that the mean load throughout the day approximates very closely to one-third of what may be termed the peak load or line, eliminating from the calculation the abnormal peaks which would occasionally occur. To meet this load fairly and effectively, the plant must, if a battery is not employed, be capable of generating the peak line, or, in other words, three times the mean day load, with the consequent result that, taking the day through, the plant is only loaded to one-third its capacity—a very uneconomical state of affairs, which will not by any means be improved by the varying nature of the load.

Let us for a moment compare the cost of two plants, one operating without and one with a battery, taking, for instance, a system calling for a mean load of 150 kw., representing a moderate-sized system of some 20 running cars.

Under the typical conditions mentioned above the maximum load which may from time to time be demanded will rise as high as 450 kw. To deal with this, therefore, in the first instance it will be necessary to instal a plant capable of generating this output, or no less than 300 kw. over and above the mean load, and on taking the cost of a complete installed plant, at £30 per kilowatt, which I think will be admitted to be a fair and reasonable figure, this means no less than £9,000 in surplus plant over and above the £4,000 to £5,000 plant which must of necessity be employed to deal with the mean load.

In the second instance, by employing a battery to deal with the demand over and above the mean load, it will require that there should be installed a battery capable of delivering as a maximum 300 kw. The cost of a battery to comply with these conditions would approximate somewhere about £12 per kw., including booster and switchboard arrangement, making an expenditure of £3,600 as against the £9,000 in the first instance, or a clear saving in capital expenditure of approximately £5,400.

In both the above instances no allowance has been made for spare plant; this must be, of course, provided in both cases, but the necessary amount will be considerably less in the case where the battery is employed.

The above examples apply to the case in which the battery is installed at the power house. Where the battery or batteries are installed in sub-stations, their introduction will effect in addition a great saving in the cost of feeders, varying, of course, according to the existing conditions of the line, distance from power house, and various other factors. Owing to the number of these factors and the wide variations that may exist in them, it is practically impossible to formulate any idea as to what may be effected in the way of saving, though a rough idea may be easily arrived at, if we consider for a moment the work which is usually performed on any traction system by a feeder. This, of course, must necessarily vary considerably, in accordance with the traffic upon the line, but it is extremely doubtful if the aggregate of a day's working amounts to more than 10 per cent. of its full capacity. With a battery installed at a sub-station, the full carrying capacity of the feeder can be employed during the whole of the operating hours of the power station. As an instance of the enormous saving that may at times be effected, the case of the Union Traction Company's system at Philadelphia is a marked instance. The extension of this line was found to be necessary, and the service practically increased to double. It was found that it would be necessary either to build a new power house or instal a battery sub-station, as to attempt to augment the feeder system to the extent that would be demanded would necessitate such an enormous outlay for copper as to render it commercially impossible. The most carefully made calculations proved that the cost of copper alone, excluding the cost of laying, would amount to from four to five times the total cost of battery installation necessary to fully meet all the requirements, while an additional power house was found to be absolutely out of the question on account of the heavy operating expenses which would necessarily be incurred, apart from the fact that the capital cost of the battery station was considerably less than 50 per cent. of the estimated cost of the power station. These figures are sufficient to show how on the question of costs alone on the first outlay, a battery is an undoubted saving.

The saving to be made in the cost of operation is self-evident, the high load factor on the engine ensuring the highest economy in the cost of production of energy, and if it is possible to reduce, as before mentioned, our coal consumption 75 per cent. almost on this score only the cost would be justified, apart from the saving in many instances of an entire shift and the decreased running hours of machinery. The question will naturally arise here as to what the battery losses will amount to on that portion of the load that is dealt with by the battery. These are very considerably less than are generally estimated to be the case. [The actual result of four consecutive months' working of the plant from which certain of the author's curves were obtained showed that out of 234,072 units generated 8,240 were absorbed by the booster, or 3·5 per cent., and the efficiency of used to generated units worked out to 91 per cent.] The next point to consider will be what relative proportion the battery should bear to the station capacity.

To effectively instal a battery, this is a point requiring careful consideration, and will vary considerably under different existing conditions. As a general rule it may be taken that the battery should be capable of dealing with from twice the mean load in the case of small stations to half the load at large stations: a very considerable range, it will be noted, due to the fact that with the increase in number of running cars the relative variations of load will decrease, and also to a considerable extent to the size of generators employed in the case of large stations. No more definite rule can well be formulated to deal with the question, each case requiring to be dealt with on its own merits. The question will be further influenced to a considerable degree by the exact method of employing the battery.

There are several methods of employment, which may be generally divided into two main heads, namely:—

(*a*) Where the battery is employed at the power station.

(*b*) Where the battery is employed at an outlying sub-station.

Each of these two main divisions can be again sub-divided into

First, where the battery is coupled as a whole across the mains or bus bars.

Second, as the first, but with a portion of it employed as regulating cells.

Third, where it is employed in conjunction with an ordinary booster, and

Fourth, where it is used in conjunction with a differential or reversible booster.

The function of the battery under these different conditions will vary considerably.

Let us, in the first instance, take the case where a simple battery is installed at the power station without any special apparatus for its control, its two extremities being coupled direct to the bus bars. Under these conditions a certain portion of the fluctuations of load must fall on the generator, and a certain variation of voltage must be permissible at the bus bars in order that the battery may take its

proportion of the load. This is easily understood if we first consider a condition of no external load, have the battery standing at a potential of 500 volts, and the potential of the generator at 500 volts, it is now very evident that the two will balance and nothing will result. If, however, by adjustment of the governors of the engine, or by the field windings of the generator, we so arrange that the generator potential shall rise, then, as can easily be followed, the generator will charge into the battery. The load next comes on the line, which should be dealt with by the generator up to the point of its full output being reached, after which, should the load still continue to increase, the generator voltage should commence to drop, the battery voltage predominate, and the battery commence to discharge to line. As the load falls the reverse conditions will take place. This method of working must of necessity require a certain amount of voltage variation on the bus bars, and consequently on the line, and it also requires a very careful pre-determination of the precise characteristic of the generator. The results generally obtained cannot be deemed to be satisfactory, though greatly improving matters as compared with the case in which no battery is employed; they are nevertheless far behind what can be obtained with other methods of employment.

This system has, it is to be regretted, been rather widely adopted, not only at home but also abroad, and the modicum of success obtained with it has, I am afraid, resulted in rather discouraging and disappointing those adopting it.

[The author showed diagrams of the general arrangement of a battery employed on this method, and of the results obtained.]

From these will be noted the extremely small amount of work done by the battery, and the wide range of machine load—the machine load varying no less than from 160 to 210 amperes, and the battery practically getting no charge at all, with the result that it would either have to be charged by special means during slack time or after running hours. Under these conditions the battery is of little real value, and is certainly working under very bad working conditions to itself.

Another diagram showed very much the same, the generator practically following the load throughout, the battery being induced to assert itself very occasionally. These readings were taken soon after charge, and the system may therefore be assumed to be working under best conditions. The voltage curve shows a variation of over 50 volts, which cannot be deemed satisfactory.

The method of adoption at the sub-stations, where the battery is simply placed across the mains, is possibly the simplest adaptation, but the results are equally unsatisfactory. Here everything does and must depend on the rise and fall of the line voltage. At times of heavy load the volts will go down and the battery discharges, while when the load is light the voltage rises and the battery charges. As can be easily gathered, the result cannot give satisfaction, nor is there any possible chance, within reasonable limits of variation of voltage, of the battery ever doing very much, the operation of the battery being entirely dependent on the variations of the line voltage, which must of necessity have a wide range to ensure any effectual work being got out of the battery. To be perfect a storage battery should be without internal resistance, so that however great the current passing through it the fall or rise of volts across the terminals due to that current, whether charging or discharging, should be negligible—unfortunately no storage battery has been made which shows these qualities, nor, I am sorry to say, does it appear likely there ever will be.

In quite a number of cases that have come to my personal knowledge, where batteries have been installed under these conditions, they simply lie little worse than "dead" on the line. A recent instance I have in mind where a battery which had been installed with adequate boosting arrangements at a power station was, on being replaced at the power station by a considerably larger battery, itself removed to an outlying sub-station and employed there in this way pending arrangements for boosting. The battery, which has a one hour discharge rate of 150 amperes, under its old methods of working frequently discharged up to 175 amperes and over, while under the new conditions it has never been known to exceed 40 amperes. One of the foregoing diagrams also demonstrates the same poor result. The battery in this case has a one hour discharge rate of 190 amperes, and it will be noticed that the highest point ever reached is only 90, and that quite an exception. It is certainly not worth while installing a battery under these conditions if an effective result is desired from it, and further, the working conditions are distinctly detrimental to the battery.

In the second method mentioned above, namely, the adoption of regulating cells, various attempts have been made from time to time to increase the effectiveness of batteries installed either at power stations, or at outlying sub-stations, by employing a portion of them as regulating cells. Automatic apparatus for cutting cells in or out as the line potential falls or rises with variation of load has in several instances been adopted; the general result, however, has been a conspicuous failure. The method is an extremely expensive one, particularly in the case of large batteries necessitating the use of a great number of costly regulating leads and expensive switch gear to keep in order. It is almost impossible to charge the regulating cells correctly, and hence they deteriorate rapidly and become a constant source of trouble; the suddenness and rapidity of the current fluctuations being such as to make it impossible to follow them, at any rate by any automatic switches that have so far been devised. If anything at all in this direction is to be accomplished, I am of opinion that it will be by means of some automatic and interlocking rocking apparatus with mercury contacts, but I am very much afraid that the strongest feature about it will be the pyrotechnic display which will in all likelihood accompany its operations.

The third system, namely, the employment in conjunction with an ordinary booster, has met with a certain amount of success.

In this method the battery is more usually employed as a store or reservoir of energy, the charging being effected for definite periods by means of the booster current being added to that of the line, or, more generally, special feeder, and the battery discharged by being placed across the line either with or without regulating cells at times of very heavy load when the generators are running, or when the load is so light as not to justify the generators being kept running. Under both these conditions a battery can often be employed with great advantage and material saving of running expenses, but the work generally is heavy on the battery and very liable to abuse. Except to meet very special circumstances this system has no special advantage to recommend it.

The fourth method, namely, when employed in conjunction with a differential or reversible booster, is undoubtedly, at any rate as far as our present knowledge is concerned, the correct and proper way of operating a battery on a traction system irrespective of whether it is installed at the power house or at an outlying station. The general arrangement of plant at a power station may be thus shortly described:—

In series with the battery is connected the booster, which is provided with a variable field. The field is automatically controlled by the battery pressure, and the booster pressure varies exactly as the battery pressure departs from the desired constant, so that the pressure across the terminals of the battery and booster combined is constant, the whole being perfectly automatic and controlled absolutely by the windings of the booster and the battery pressure.

In the case of a battery and booster of this description employed on a traction system or any system where the load is of a rapidly varying character, the battery controlled by the booster serves to take charge of practically the whole variation, whether above or below the normal or mean load, so that the generator works at practically a steady constant load, the difference between the load and the mean charging the battery when the line load falls below the mean, and the battery discharging to line whenever the load exceeds the mean. The generator load will naturally be adjusted to be the mean load required to generate the total average output for the usual period of work.

The general features of this arrangement which commend it as being of special value on a tramway system may be summed up as follows:—

The first cars run out in the morning, and under precisely similar conditions of energy supply, can be worked entirely from the battery, thus obviating the necessity of starting up the power station for a few early workmen's cars some two or three hours before the general load comes on. During the day the battery will be intermittently charging and discharging, the output of the generator or generators being fixed at such an amount that at the pre-determined time of shutting down the battery is fully charged. Should the battery be found not to be in its normal state of charge at shutting down, owing to any abnormal demand, the running time can be prolonged, or the loss compensated for by slightly increasing the generator output the next day, *vice versâ* if the battery is overcharged, the output may be decreased. The power station can be shut down on the heavy load falling off, the remaining late cars being run as the early morning ones off the battery only. The advantages of working a plant under these conditions are self-evident.

Working at full constant load, the greatest possible economy can be ensured, the actual running hours shortened, and the most uneconomical and unprofitable hours in every sense of the whole day's work avoided. The minimum of plant running necessary for operating the load, wear and tear on the plant generally will be much less, the load on the generators being practically constant, ordinary shunt wound machines may be used, though the system works as perfectly with compound-wound machines. The switching gear is of the simplest description, and is reduced to a minimum, and the whole arrangement absolutely automatically controls itself.

The general working conditions are most favourable to the life of the battery, the latter being kept constantly fully charged, and immediately charged after discharge.

[The author showed some highly interesting curves obtained under different conditions with a tramway system, in which a battery and booster of this description form part of the power station equipment.] The steady generator load is particularly noteworthy, also the range of the total load curve, the variations of which are taken almost entirely by the battery.

These curves are further interesting examples of how a load on the same system may vary, due principally to conditions of traffic and weather, practically the same number of cars running in both cases, while the mean load differs widely.

The actual recorder curves, which I regret to say I have not been able to get reproduced, show very clearly the results which can be obtained on a system equipped with a battery and booster. The two most interesting curves are those showing the battery voltage and the line voltage — the difference between the two is entirely due to the booster. Employing a battery without a booster, the battery voltage, and probably rather worse, would represent the line voltage. The different curves on each of the sheets were taken simultaneously.

The battery must, of course, be properly adapted for the work it has to perform. It must be capable of being charged at very high rates without injury, and of the minimum possible internal resistance, so as to ensure the least possible range of voltage. These conditions are best met with in plates of the Planté type, and with such the battery losses amount to but a small percentage of the total load.

As can readily be understood, a great deal depends on the design and construction of the booster necessary to properly carry out

these functions. Up to quite recently the differential or reversible booster has been practically unknown, and those machines which did exist can scarcely be looked upon as being either highly effective or highly efficient. The extended adoption of batteries in connection with power plants has, however, created a demand, and of late considerable attention has been paid to the construction of this type of machine, and various methods and arrangements have been designed to meet the necessary requirements; in many instances the results have left very much to be desired, and in cases where the working may have been passable, the efficiency has been such as to preclude their being considered. There is very little doubt but that the most successful machine that has so far been introduced is that for which Mr. J. S. Highfield is responsible. By this machine all the functions above mentioned are attained to a remarkable degree, and with the highest efficiency. The booster is a distinctly novel departure, in that it consists of three distinct machines, namely, a motor, generator or booster, and exciting controller, by means of which the unwieldy and waste windings, which have prevailed in all other machines, and which have seriously impaired their efficiency, have been avoided.

The function of the third machine is to control the excitation of the booster, and it runs in direct opposition to the battery current; by this means the requisite field reversals are obtained.

Operating a traction or power system with a machine of this type practically results in the battery becoming, as it should do, the real regulator of the system.

The extent to which a battery should control or regulate a system is an interesting factor. Personally, I am of opinion that it should take the sole and entire charge and control of the whole, even to the extent of not excluding the engine—in other words, the engine should be run without a governor on a constant steam pressure and constant valve admission. This will, doubtless by many, be considered to be a bold departure, but I am convinced myself that the best curves hitherto obtained might be still better under these circumstances, and that the small generator variations that do occur are due to the governor attempting to take the load instead of leaving it entirely to the battery to compensate for as should be the case. The abolition of the governor on a power station engine is the consummation of an ideal devoutly hoped for, but I am certain in many instances with a proper equipment of battery and booster it is perfectly feasible.

In closing this paper I must express my thanks for the kind assistance rendered me, both by information and curves, by Mr. McMahon, of Bispham, and Mr. Highfield, of St. Helens.

Discussion.

Mr. F. P. Wood congratulated Mr. Grindle on his very interesting paper. As regards his remark about driving without governors, he (Mr. Wood) thought there were very few engineers who would agree with him on that point, and as regards differential boosters he supposed those must be used in generating stations. He did not think there could be much advantage in using batteries when the load exceeded 50 cars, because in that case there was very little variation in the dynamo current. He thought it would not be of much advantage in relieving the dynamos, save in the early morning and in the evening.

Mr. Highfield (St. Helens) said that one of the most important financial advantages of the battery in his works, where they ran 27 to 30 cars, was in the saving of running two shifts. They drove for lighting, from the trolley feeders as well as for the cars. The line was being kept alive for 24 hours. For this purpose the battery was of exceeding use in the saving of wages. Without it they would have to pay at least £200 per year, the whole of which was saved. With regard to the cars, the loads for them went from 30 amperes to as much as 350 amperes. They had taken about 459 amperes from the battery and the boosters. The plan of using a battery did not apply to a tramways station only, but to where a station was used for supplying a lighting load. For lighting work the shunt-wound generator was a better machine than a compound-wound. If they were going to work a lighting load from a tramway station without batteries, it was necessary to put down compound generators for the tramways load. If they used a battery they could drive the tramway load or the lighting load quite indifferently with advantage. They could have two batteries—he used two himself—and use them indifferently on the traction or on the lighting load.

The Chairman remarked that Mr. Highfield had worked out a very unique and ingenious system of boosting both into the battery and out of the battery and had installed it in the station at St. Helens, where it had been at work for more than a year with most conspicuous success. He (the chairman) asked Mr. Highfield, was the battery working as he described, being constantly charged and discharged? What did he find to be the efficiency and the energy? Another point was, it did not appear to be quite clear what the range of efficiency was when working under those circumstances. He (the chairman) would also like to ask, when the battery was used in that floating method, what was the cost of wear and tear? Was it any greater or less than by the other way with which they were acquainted? Did he find it to answer to fully charge the battery, and could he keep it in perfect order while charging and discharging?

Mr. Highfield said that he would speak about efficiency with considerable doubt, because he had fixed in series with the battery a type of battery meter with two dials, which they had run for two months. The charge was about 12 per cent. of the total units generated, and the discharge between 10 and 11 per cent. of the total. The efficiency was between 80 and 85 per cent. He did not like to take those figures without testing them, so he took the meter down and found the two dials were revolving equally; so he had to abandon the meter, and was then waiting for a meter with which to carry out the trials in a proper manner. They found that the mean current for the day with 21 cars was from 200 to 250 amperes. To keep the generators as full as possible they stopped work between six and seven o'clock on a generator of 125 kw. They arranged so that at the end of the period of running, about 11 o'clock, the battery was full up. They took the specific gravity when the battery was as full up as they could get it. As regards maintenance he could not give any figures, they had not been working long enough. All he could say was that they had been working for 18 months.

Mr. Cooper could not agree with Mr. Grindle in one thing. If they had a car load which took about 450 kw. he did not think, if they designed it properly, they would want to put down a 450 kw. plant. He would like to know what maintenance allowance Mr. Grindle would ask to keep a battery up to its full capacity.

Mr. B. S. Giles took the question to be: What was the least voltage at which a cell could be charged and never exceed it? He had lately had to go into that and found that it never required more than 2·2 or 2·3 volts to charge. He would also be very glad if Mr. Highfield would tell them what would be required to keep the battery in good working condition? As regards abandoning the governor, he did not follow him at all. It would in many cases mean courting disaster. Having an engine coming to pieces would be very disastrous.

Messrs. Bailey, Cooper, and E. W. Cowan (hon. sec.), having briefly spoken, Mr. Grindle replied. As regards twice the mean load, a battery, he said, should be comfortably able to discharge that, and to do it for at least half an hour. As regards cost, boosters working under the new conditions were decidedly more advantageous than under the old system. From 2·2 to 2·3 volts was absolutely sufficient to keep a battery in perfect order, and as a margin, it was ample.

A vote of thanks was passed to Mr. Grindle for his paper, and the meeting came to an end.

ELECTRICAL DRIVING IN ENGINEERING WORKS.

A lengthy paper dealing with "Workshop Practice at the Beginning of the Twentieth Century," was read last Saturday week by Mr. E. C. Amos, M.I.M.E., before the London Association of Foremen Engineers and Draughtsmen. The author's remarks on methods of driving which are reproduced below will be interesting at the present moment, in view of the increasing attention now being devoted to the electrical operation of engineering works:—

In these days of keen competition it is becoming a matter of serious consideration as to how to reduce cost while at the same time maintaining good work, and manufacturers are rapidly beginning to realise that the highest efficiency can only be obtained where every department is right up to date. The writer, when inspecting various works from time to time, has often been struck with the obsolete methods adopted in driving the plant, itself perhaps quite up to date. Again, the various shops may be fairly up to date, but a visit to the engine room discloses a condition of things that has very little regard for economy in fuel consumption. Anything that will turn the main shaft round seems to satisfy at many works, and this state of things is not confined to this country. Increase in the price of coal and the introduction of electric driving are, however, helping to produce satisfactory changes. As to electric driving, this method is now making great headway, but I am well aware that there are still many opponents of it in this country and even on the Continent. This is largely due to the fact that its economical introduction into existing works is a matter of considerable expense. At first sight one might argue that there is nothing simpler than to replace the old antiquated engine and boiler (so common in many works, but whose fit place is in the scrap heap) by a modern high-speed engine, economical boiler and dynamo, but advantageous as this might be, and is in many cases, this is not a complete solution of the difficulty. The old engine probably ran at a slow speed, the line shafting is consequently heavy, and the bearings, pulleys, &c., not suited to run at the high speeds suitable for an electric system of main shaft driving. In nearly all large works, however, even where the old system obtains, there is considerable use for the electric current, especially where it is desired to drive isolated machines, and for transportation within the works. In fact, so great are the advantages that many existing works are at the present time pulling out their old plant entirely, and it is not too much to say that every new works of importance, or those wishing to be in the van of progress, will embody the electric system. As to the methods to be adopted this must largely be determined by the nature of the works. The practice at the present is either (1) to drive line shafting by motors, or (2) to drive each machine with a separate motor. One, or a combination, of these systems is certain to become very general before long. Our leading manufacturers mostly favour the first system, although they also admit that the larger machines can be advantageously driven by a separate motor. One of the difficulties associated with motor driving under the second plan, and especially when using small motors running at high speed, is the question of reduction and variation of speed. As is well known, most forms of motors, whether electrical or otherwise, are most efficient at one speed or within a limited range, and any great deviation produces consider-

able loss of efficiency. In the writer's opinion, however, it is only a question of time when the great advantage of what may be termed the localising of the application of power by having each machine self-contained and separately driven by its own motor, will be so fully appreciated as to stimulate our electrical engineers to supply us with a motor which will answer to the requirements of the mechanical engineer. It is only a few years ago that the electrical transmission of power through a distance of, say, 150 yards, was done at a loss of something like 30 per cent., whilst under 5 per cent. will now cover it, so that it is not unreasonable to suppose that as great an advance will be made in its application to driving machines. Whilst the system is much more expensive in first cost, the cost of working is less, and the increased facilities offered in the shape of convenience are rapidly becoming appreciated.

The following information was given to the writer by a large firm making extensive use of electrical driving. They consider that in all ordinary cases where tools are properly arranged, it is advisable to drive the machines in sections; but where large tools are in question, which may probably have to run overtime or night shifts when other adjacent machines are standing, they would advise independent motors. Where there are a large number of small motors, a greater amount of attention, repair, &c., is necessary, and the efficiency is not so good as where fewer and larger machines are in use. As regards the general efficiency of electric driving *versus* the ordinary line shafting from engine to shaft, their own experience is that it would have been impossible to do the amount of work they are now doing on the old system. Probably the old arrangement was a bad one, but still that would apply to nine establishments out of ten. Another opinion on this point, and one based on the present day experience of an up-to-date machine-tool builder, proposes the use of medium speed multipolar motors of not less than 15 H.P., and driving one, two or three shafts as the case may be. Whilst admitting that these are good arguments in favour of using a separate motor for each machine, they consider that, excepting the case of shops using a number of heavy tools, the cost would be prohibitive. One of the greatest advantages they derive from electric driving is the driving of tools while being tested. The shop in which the tools are tested has a false wood floor about 5 ft. above the ground level, and to carry the cables to various parts of the shop is a very simple matter. The motors for this purpose are 8-H.P. each, and are secured to the floor wherever required by coach screws. Apart from the advantages and saving already indicated, the opportunity presents itself under this system of taking exact readings of the power consumed by each machine. This will not only cause considerable surprise, but will lead to a lot of useful data being obtained in many ways. It is also especially valuable when it is desired to ascertain the horse-power required to drive any new machine, and enables makers to inform their clients the power they have to provide for driving such machine. In addition to the driving of fixed machines, electricity is receiving very extensive application in respect to portable tools of the type of the pneumatic tool, and for some purposes competes very favourably with the air-driven machine. Machine tools driven by their own motor are rapidly coming to the front, and a good illustration of this type is shown by the travelling multi-spindle drilling machine made by Messrs. J. Butler & Co., of Halifax. In such a machine any other form of driving is almost impossible, or, at any rate, would seriously handicap the utility of the machine. In addition, however, to the advantages already pointed out, there is yet another in respect to electric driving which must not be lost sight of. As is well known, the demand for power in all engineering establishments, however well designed and arranged with a view to keeping all the machines fully occupied, is more or less erratic, and this is where the electric system comes in. Where power is distributed by such mechanical means as belting and gearing, the greater portion of it goes in driving these vehicles of transmission. I think I am not exaggerating when I say that were you to run an average mechanically-driven shop empty, *i.e.*, with all the machines on the loose pulleys, you would find the engine required to run at between 50 per cent. to 80 per cent. of its full power as compared with running the full load. With an electrically-propelled shop the loss is nothing like as great; in fact, half this is more than sufficient to cover it, since when any machine is thrown off (I, of course, refer to machines with self-contained motors) the prime mover is at once relieved, whilst under the mechanical system the shafting, belting, &c., have still to be driven. Much might be written on this part of the subject, setting forth still further advantages, such as increased space and light obtained by doing away with overhead gears, driving machines in any position instead of being controlled by line shafting, and as is often the case, having to put a planer or shaper where it wastes room and is dangerous; but enough has probably been said to indicate the change that is likely to be made in this direction.

I may perhaps sum up what appear to me to be the chief and dominating essentials which every engineering works (and to a large extent other works) will have to embody in this twentieth century, and without which few shops (and those only of an exceptional nature) will be able to exist. From a knowledge of what is already taking place in this and other countries, both in respect to the development of mechanical and other forces and with regard to labour, I am convinced that this century will see great and rapid changes in workshop practice and methods. Definitions are always difficult to frame, but the headings may perhaps be treated thus:—

1. The equipment of a works must be controlled by a consideration of the works as a whole, and any addition be regarded in the same light, attention being specially paid to the application of power and the means of transportation and handling of work during progress of manufacture.

2. Machines to be of latest type, whose value shall be measured by capacity for output, and that alone, irrespective of prime cost. Such machines, however, to be replaced as soon as they are improved upon.

3. The health, comfort and recreation of the employés must be recognised to be as important a factor as the acquisition and care taken of up-to-date machinery.

These may be placed in whatever order you please, as I consider they are all equally important, and you may also elaborate them; but stringent as they may appear to some, or costly and impossible as they may seem to others, and especially proprietors, I yet venture to think they embody sound, economical, profit-making, and not least, humane principles, without the carrying out of which no industry in the future will be able to thrive.

THE BELLEVILLE BOILER.

In a recent number of the *Pall Mall Gazette* a further series of facts is thrown out. We think our contemporary deserves well for the persistent and steady manner in which it has continued to point out the defects of the Belleville boiler, and the danger to the country which is being run by the present Admiralty policy. Our contemporary's correspondent has been spending a whole week at Chatham, Portsmouth and Devonport, and he states that the utmost secrecy is being observed. It is reckoned as high treason to say anything of Belleville boilers outside the gates of Keyham or the dockyards. The correspondent aforesaid, however, saw the *Hermes*, which came home with a deck full of burned-out tubes in December last, and now lies helpless without a boiler inside her, and the *Hermes* is one of our new ships—a member of our first line of defence. Then there is the *Highflyer*, hidden out of sight of the taxpayer in the East Indies, and waiting a relief ship so that she may creep, or try to creep, home. An engineer, who knows something of affairs, says that every water-tube boilered ship goes wrong from time to time, and is always in a more or less defective condition. The Boiler Commission has been out in the *Hyacinth*, and "bust her bilers" for her, having, it appears, run her too hard.

The best ship the Admiralty could pick to be tested against the Scotch boilered ships has failed, and yet they still go on putting the Belleville boiler into new ships with the certainty of inevitable failure staring them in the face. There are a full dozen ships under repair now, and more are coming in; these are only our home ships, while whole cargoes of tubes are going out to foreign stations to keep things going in some sort of shape. The *Swordfish* has failed, and has not even been through one commission. The *Ostrich* and the *Falcon* have never even had steam up since they were sent home from their builders. The *Mutine* failed on her delivery trip and killed some stokers. Our contemporary describes the Belleville boiler as rotten in principle, with which we cordially agree, and we have continually urged this same fact.

It is said that in the Italian Navy the Niclausse boiler has, with the Belleville, also proved a failure. We can hardly think the Niclausse can be so bad as the Belleville. We believe, however, that even the boilers that might have a show are ruined as regards fuel economy and smokelessness by the arrangements of their furnaces. We have condemned the furnace arrangements of water-tube boilers time and again, the entire disregard of any arrangement for the mixture of the gas and air, the utter absence of a refractory lining to the furnace, or of any space for combustion to complete itself. Only two boilers have been since pointed out to us in which these things have been either done or attempted. One of these is the Weir boiler, in which not only are the gases kept away from the tubes until combustion has been allowed to complete itself very considerably, but a very large space is deliberately provided for the purpose—designedly placed there for the purpose, as though the combustion of coal did really occupy some space in the thoughts of the designer—a very happy exception to the ordinary habit of crowding tubes into a minimum of space, as though tube surface were all, and furnace volume nothing. We trust our contemporary will continue its crusade. No subject at this moment is more important, more essential to the safety of the Empire, than this one of boilers for our fleet.

POWER GAS AND LARGE GAS ENGINES

(*Continued from page* 303.)

Gas Producers Compared with Steam Boilers.—Turning now to the subject of gas producers as compared with steam boilers, it will at once be obvious that gas under a slight pressure is much easier to handle than high-pressure steam, and when steam mains cease to be necessary, a cause of danger and trouble is removed; also the losses due to condensation disappear at the same time. It is perhaps of still greater importance that the working, as between producers and gas engines, can be controlled automatically in the most perfect manner, so that the gas supplied is always equal to

the gas consumed. At Winnington, where 1,000,000 cubic feet of gas are consumed per hour, and demands for gas are by no means regular, there is no gas holder or storage of any kind. A Mond producer will respond at once to a sudden increase in demand for gas, whereas a steam boiler takes time to rise to the increased output, and the boiler foreman has his anxious half hour as the peak of the load curve arrives for his station. The speed of the air blower furnishing the blast to the producers can be controlled by the pressure of gas in the supply mains, and any fluctuation is automatically balanced so as to keep the supply pressure constant. The limits within which a Mond producer will make good gas are surprising, while a producer can be shut down and left with fire in it for over a week and still be quite ready to start again at short notice. With producers the stand-by losses are reduced to a minimum, and thus another serious waste is avoided when compared with steam practice. It should be made quite clear, however, that when the Mond plant is arranged for the recovery of ammonia some steam is required in order to provide the balance of water vapour necessary to saturate the producer blast. This steam can be raised by utilising the heat of the exhaust gases leaving the gas engines, and a large plant has been designed and will be erected in which all the extra steam required will be raised in this manner. But where it is not convenient to extract the heat from the exhaust gases some steam boilers become necessary. Such boilers could be gas-fired and the control rendered automatic. If the recovery of ammonia is not attempted, less steam is required in the blast, and arrangements can be made to do without the steam boilers. In a large station, however, the sacrifice of the ammonia represents about 4s. 6d. per ton of slack. Also, as the recovery plant is very simple, station engineers should welcome this source of economy with the same readiness with which they will appreciate the use of cheap bituminous fuel.

In the Mond gas plant, it is claimed, there is found a perfect system of producing cheap power gas, which, when combined with the use of gas engines, forms the cheapest, the most scientific, and most economical method of dealing with fuel. Several companies have grasped this fact and adopted the system, and soon there will be some 2,000 to 4,000 H.P. at work. It is significant that the Northwich Electric Supply Company preferred to buy Mond gas, and pay as much as 2d. per 1,000 cubic feet for it, delivered under pressure on their premises, rather than use the water-power available in the district.

Cost.—The question of cost is a crucial test, when once the absolute reliability of the system is assured, and its recommendation must be based on the commercial results to be obtained. The cost figures can be fairly closely estimated on the basis of the Mond plant at Winnington, where 150 to 230 tons of fuel per day are gasified. All that was attempted in the present paper was to give a general idea of the cost of working a central station under a fixed set of conditions, and in the following table all charges on capital outlay for land, buildings, gas-dynamos, &c., being capable of estimation from data, which would be somewhat modified to suit each individual case, have been purposely omitted. The station has been chosen at 20,000 E.H.P., and the load factor assumed at 100 per cent., 50 per cent., and 33⅓ per cent. respectively. The first case only applies to an electrolytic plant, but the other cases may well represent a central station of the future supplying energy in bulk. The cost of fuel, oil, labour, repairs, and maintenance, ranges from 0·082d. to 0·241d. per unit sold, according to load factor and price of coal.

Estimate for a 20,000-E.H.P. Central Station Gas Engine Plant worked with Mond Gas.

Conditions of Working.—Mond gas producers and recovery plant worked in conjunction with gas engines and dynamos. All extra steam raised by utilising the gas engine exhaust heat. The electric energy (1) consumed on the premises for an electrolytic plant; (2) transmitted a short distance, and sold in bulk with a 50 per cent. load factor; or (3) with 33⅓ per cent. load factor.

A gas dynamo at full load takes 105 cubic feet of Mond gas at 0° C. to give one unit (kilowatt-hour). Allowing for a somewhat reduced efficiency at part load, and for driving auxiliary machinery, &c., the liberal figure of 125 cubic feet per unit will be taken. Then 1 ton of coal will yield gas for 1,059 units, and it is assumed that 1,000 units are actually sold.

Output:—
Number of units sold per ton of slack gasified ... 1,000

Slack Cost per Unit sold (pence):—

	d.
With slack at 3s. per ton	0·036
„ 4s. „	0·048
„ 5s. „	0·060
„ 6s. „	0·072
„ 7s. „	0·084
„ 8s. „	0·096
„ 9s. „	0·108
„ 10s. „	0·120

Working Producers, Recovery, and Sulphate Plant:—
Cost of discharging and handling slack, working producers, recovery, and sulphate plant, and including administration, wages, repairs and maintenance, stores, acid, lighting, &c.
Per ton of slack gasified ... ... 3s. 6d.

Value of Sulphate Recovered:—
At £10 per ton of sulphate, naked at works; and with 25 tons of slack gasified, yielding 1 ton of sulphate of ammonia.
Per ton of slack gasified 8s. 0d

Profit Due to Sulphate Recovery:—
Being credit for sulphate less working expenses.
Per ton of slack gasified ... ... 4s. 6d.
or per unit of electric energy sold... ... ... 0·054d.

Net Cost of Mond Gas per Unit sold (pence):—

	d.
With slack at 4s. 6d. per ton	0·000
„ 5s. „	0·006
„ 6s. „	0·018
„ 7s. „	0·030
„ 8s. „	0·042
„ 9s. „	0·054
„ 10s. „	0·066

—	Load factor. 100 per cent.	50 per cent.	33⅓ per cent.
Power Plant (pence per unit sold):—			
Oil, waste, and petty stores ...	0·030	0·030	0·030
Labour and attendance	0·034	0·051	0·068
Repairs and maintenance... ...	0·036	0·058	0·077
Total Cost per Unit Sold (pence):—			
With slack at 3s. per ton...	0·082	0·121	0·157
„ „ 4s. „ ...	0·094	0·133	0·169
„ „ 5s. „ ...	0·106	0·145	0·181
„ „ 6s. „ ...	0·118	0·157	0·193
„ „ 7s. „ ...	0·130	0·169	0·205
„ „ 8s. „ ...	0·142	0·181	0·217
„ „ 9s. „ ...	0·154	0·193	0·229
„ „ 10s. „ ...	0·166	0·205	0·241
Capital Account:— (Producers and recovery plant only, and allowing 20 per cent. reserve on all plant)			
Slack handling, regenerator plant, and gas producers	£26,500	£26,500	£26,500
Acid towers, recovery and sulphate plant	23,500	18,700	17,100
Steam-raising plant and sundries	19,000	19,000	19,000
Total ...	£69,000	£64,200	£62,600

Note.—No charges on capital account, rent, rates, or taxes are included in the above figures.

As regards capital outlay, the combination of Mond producers, recovery plant, gas engines, and dynamos, compares favourably with the best class of steam-driven plant, when the boiler house, chimney, slack-handling plant, foundations and erection, are included in the cost of steam dynamos, boilers, condensers, and auxiliary machinery. From actual experience with 400-H.P. units, the cost of gas engines, dynamos, fly-wheels, &c., with foundations and erection, is £12·42 per E.H.P. capacity, or £16·64 per KW. Adding to this the cost of the complete producer and recovery plant, with its buildings, &c., at £4·62 per KW. (including 20 per cent. reserve) a total is obtained of £21·26 per KW. With large units this cost would be materially reduced, and £15 or £16 per KW. would probably cover the cost with a 20,000-E.H.P. plant.

To pass for one moment from large schemes to small ones, it may be of interest to state that Mond producer-

plants have been designed to supply gas for small powers down to 250 H.P. of gas engines. These plants are very simple in construction, and work under an important patent of Dr. Mond's, whereby a portion of the exhaust gases from the gas engine is introduced into the producer blast, thus keeping down the temperature of the producer without the use of extra steam. In these small plants no recovery of ammonia is attempted, and the apparatus is only intended to supply the requirements of isolated places where a good power or heating gas is necessary.

In conclusion, the author expressed his thanks to Dr. Ludwig Mond for his kind permission to place before the Institution much of the information contained in the paper. Most of the experiments were carried out for Dr. Mond at his expense and that of the great firm of chemical manufacturers with which he is associated, and through Dr. Mond's generosity it has been possible for the author to embody the more important results of this work in the present paper.

The general conclusions to be drawn from the particulars given by Mr. Humphrey go to show that gas engines are quite suitable for driving dynamos for producing electricity under central station conditions.

They can be direct coupled to either direct or alternate-current generators, and successfully run in parallel. They can be made in units of power up to 1,500 I.H.P.

For stations of over, say, 1,000 H.P., Mond producers can be very economically installed, giving a low consumption of fuel, with the additional economy of recovery of by-products, while where blast furnace gas is available, an economy over applying the gas to steam boilers of about four to one can be obtained.

The paper also indicates that large power gas engines are giving such satisfaction that the units of power are rapidly increasing, as well as their application for economically producing electricity.

For the successful running of gas engines a supply of gas of very constant chemical composition is absolutely necessary, and that generated by the Mond producer appears from the paper to meet the requirements of even central station practice.

CURRENT SPECIFICATIONS.

LII.—NEWPORT CORPORATION TRAMWAYS AND POWER.

Summary.

Extent of Contract.—Section 13.—Supply and erection upon prepared foundations of three vertical cross-compound condensing engines. Section 14.—Supply and erection of three traction generators upon prepared foundations.

Type of Engines.—Vertical engines, with Corliss valves and valve gear, with provision for placing the dynamo armature upon crank-shaft between engine cylinders.

Size of Engine.—Each engine to have H.P. cylinders 22 in. diameter, L.P. cylinder 44 in. diameter, and a stroke of 42 in.

Output of Engine and Speed.—Each engine to run at 90 revolutions per minute, and to be capable of developing as normal full load 800 I.H.P. and maximum full load 1,000 I.H.P.

Conditions of Working.—Steam pressure, 150 lbs. per square in., a vacuum of not less than 25 in. being maintained by separate condenser at exhaust of engine.

Range of Governing.—1½ per cent. on either side of normal under any conditions of load.

Requirements for Independent Working.—Engine to be so arranged that either high or low pressure side can be worked separately and develop with safety 600 I.H.P.

Minimum Weight of Engine.—To be not less than 120 tons.

Weight and Dimensions of Fly-wheel.—19 ft. diameter, to weigh not less than 80,000 lbs.

Specified Steam Consumption of Engine.—14½ lbs. per brake horse-power-hour when working with 150 lbs. square in. steam and 25 in. vacuum, steam containing not more than 2½ per cent. of moisture.

Penalty for Non-compliance with Specified Steam Consumption.—£250 for each ¼ lb. with option to engineer to entirely reject engine if amount exceeded by more than 1 lb.

Bonus for Improved Steam Consumption.—£250 per ¼ lb. on above figure.

Stipulated Efficiency of Engine.—Not less than 92 per cent. at full load.

Output of Dynamo.—500 KW. as shunt at 500 volts arranged to give as shunt machine any voltage between 450 volts at no load and 500 volts at full load. To be suitable for giving as compound-wound machine 500 volts no load, 525 volts at normal full load.

Specified Overload.—750 KW. at 525 volts without sparking, the brushes being kept in a fixed position.

Permissible Temperature Rise.—With load of 1,000 amperes, 525 volts, not more than 81° F. in either field coils or armature winding measured by resistance method, or 63° F. measured by thermometer placed in any accessible place.

Specified Efficiency.—Full load not less than 93 per cent.; ¾ load 92·6 per cent.; ½ load 92·4 per cent.; all including field losses.

Specified Dates of Delivery.—Including erection, first complete set eight months from date of order, second set nine months, third set ten months.

Specified Penalty for Late Completion.—First set, £50 per week for either engine or dynamo; second set, £50 per week for either engine or dynamo; third set, £25 per week for either engine or dynamo.

Specified Terms of Payment.—75 per cent. of contract sum on delivery on site, 15 per cent. on completion, 10 per cent. at end of period of guarantee.

Period of Guarantee.—Twelve months from date of completion.

Period of Supervision of Running of Engines by Contractor.—Not less than four weeks from date of completion.

Stipulations as to Removal of Foreman.—Acceptable, though the wording of the clause is very peremptory.

Stipulations as to Wages to be Paid to Workmen.—Trade union rates to be paid.

Arbitration Proposals.—Unsatisfactory. See comments below.

Date for Receipt of Tenders.—March 25th, 1901.

This specification for the supply and erection of three 500-KW. steam dynamos for either lighting or traction purposes, has been prepared by Mr. H. F. Parshall, M.I.C.E., the consulting electrical engineer to the Newport Corporation.

It is stipulated that tenders shall be sent in in *wax-sealed envelopes*, and perhaps this best expresses the character of the whole of the specification.

Every detail is specified in Sec. 13 relating to the engines, the exact type of engine, sizes of cylinders, stroke, speed, class of valves, size of parts, weight and diameter of fly-wheel, minimum weight of engine, all these are specifically stated. And after thus insisting upon the *means to be adopted*, the *results to be obtained* are specified, the contractor being heavily penalised if they are not obtained. True, if improved upon, a bonus is promised, but we submit that, as stated by Mr. R. P. Sellon in his paper to the Institution of Electrical Engineers last year, the principle is wrong. The function of the consulting engineer is to specify results; the duty of the contractor is to find out the means by which those results may be obtained.

The same remarks hold good for the dynamo specification, though here it is stated that manufacturers may quote for their own standards, stating in their tenders where these differ from the specification.

The express statement, "*The conditions of this specification are preferred*," is, however, likely to have the effect of discouraging manufacturers from taking advantage of this permission.

Leaving, however, the technical portion of the specification, we find that the arbitration clause is unsatisfactory. A distinction between financial and engineering disputes is made, in the former case an appeal from the engineer's decision to an independent arbitrator is permitted, in the latter the decision of the engineer "*shall be final and binding upon all parties.*" We do not consider an arbitration clause of this description at all satisfactory, and we urge all the tenderers to carefully scrutinise its provisions before accepting them.

We note the following clause *re* trade union rates of wages, and trust it may have the effect of limiting competition to British firms, upon whom it is specially binding.

The contractor will be required to enter into a covenant, subject to a penalty of £5 for every breach thereof, that he will pay trades union rates of wages and observe the recognised hours of labour prevailing in the district affected, the same to apply to sub-contracts, and also *to post up a copy of this clause in every department where such work is being carried out.*

The penalty conditions are very severe, and should be carefully considered before acceptance; and it is expressly stated that sub-letting any portion of the work does not in any way relieve the main contractor of any of his liabilities or obligations.

REVIEWS.

Theory and Calculation of Alternating Current Phenomena. By Charles Proteus Steinmetz with the assistance of Ernst J. Berg. Third edition. New York: *Electrical World and Engineer.* 1900.

This treatise, as indicated by the title, contains a fairly complete exposition of the theory of alternating current phenomena. Mr. Steinmetz has long been known to us as an investigator of alternating current phenomena, and none is better qualified than he to compile a treatise on the subject. The book while ostensibly surveying the whole subject naturally has its greater portion devoted to those branches which may be termed peculiar to its author.

Mr. Steinmetz is probably the pioneer in the application of complex quantities to the calculation of alternating current problems. This is really a system of vector algebra in one plane, and undoubtedly is a labour-saving process. This is, however, not the only property which recommends it, for it cannot be used without first thoroughly understanding the physics of the problem, and at any stage of the process the equations admit of being easily physically interpreted.

There is one point in connection with Mr. Steinmetz's method of treatment which we would like to see altered, although it is perhaps of minor importance. Taking a simple reactive circuit of resistance, r, and reactance, s, the reactance being inductive so that the reactive E.M.F. lags a quarter of a period behind the current. Suppose that j represents a positive rotation of the unit vector through 90°. The positive direction of rotation is, as is customary, taken in the counter-clockwise direction.

The impressed E.M.F., e, has to drive the current, i, against the resistance, r, of the circuit, and also to balance the reactance E.M.F. $-js\,i$. Thus we arrive at the simple vector equation of E.M.Fs.

$$r\,i + j\,s\,i = e.$$

We think that this equation is preferable to the form

$$r\,i - j\,s\,i = e$$

adopted by Mr. Steinmetz, although which ever form is employed the physical equations ultimately arrived at are the same. The author employs vector algebra almost universally throughout his treatise, so that the method must be fully understood by anyone wishing to read it. This, however, is no drawback, because vector algebra, such as is requisite for the greater number of alternating current problems is so easily grasped and the assistance derived therefrom so very great, that no one possessing a fair knowledge of elementary mathematics need be afraid of attacking it with full assurance of success.

Where the author departs from the methods of vector algebra, he unfortunately becomes somewhat laborious. An example of this occurs in the chapter on the Synchronous Motor. The deductions are arrived at most laboriously from the fundamental equation, whereas they are more instructively and quite easily obtained by treating the power equation $p + r\,i^2 = e_0\,i\cos\psi$ as a quadratic equation in i. The solution of this gives

$$i = \frac{e_0\cos\psi \pm \sqrt{e_0^2\cos^2\psi - 4\,r\,p}}{2\,r}$$

which immediately gives the maximum power and corresponding current.

The book is well compiled, and is comparatively free from errors. The only error discovered after a careful reading is on page 129, where, on the last line but two, the word *inversely* should be deleted.

Mésures Electriques. Leçons professées à l'Institut Electrotechnique Montefiore à l'Université de Liége. By Eric Gerard. Second edition. Paris: Gauthiers-Villars. 1901.

This is a general account of the methods and instruments of measurement used by electrical engineers, including steam engine indicators and photometers. The first chapter gives some slight account of the theory of errors and of the nature of the units used in electrical measurements, but the book is, in the main, a description of electrical instruments, of which a large number are illustrated. The information given on the details of construction is very slight, being no more than is necessary to give a student a fair general knowledge of the different kinds of apparatus available for such work as he may have in hand. No doubt the book is much less valuable than were the original lectures, when the actual instruments were, presumably, exhibited on the professor's table. It would hardly help an expert electrician, but would be valuable to a student—the purpose for which it is, of course, designed. It is a well-printed octavo of 532 pages, and, what is unusual with French works, is published in a cloth binding.

Exercises in Natural Philosophy. By Magnus Maclean, D.Sc., F.R.S.E. London: Longmans, Green & Co. 1900.

The problems dealt with in this work have been selected mainly from the weekly papers set to the students of the Natural Philosophy classes so long conducted by Lord Kelvin at the University of Glasgow. They include examples in all branches of physics, and not only are the numerical exercises fully worked out, but in many cases a brief introductory statement of the general theory of the subject dealt with is added. A number of physical data and 35 tables of physical constants form an appropriate and useful appendix to the book, which should prove of great assistance to candidates for degrees in science.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

3,964. "Improvements in electric igniters for internal combustion engine and the like." A. G. New. February 25th.

3,965. "Improvements in automatic and safety subsidiary devices for controlling electrically-propelled vehicles and the like." A. G. New. February 25th.

3,967. "Improvements in dynamo-electric generators and electric motors." A. Dickinson and T. Preece. February 25th.

3,972. "Improvements in machines or mechanism employed in the manufacture of pipes or tubes, or for covering telegraph and telephone cables and wires with lead or other metallic substance for electric purposes." E. A. Clarémont and J. Stratton. February 25th. (Complete.)

3,992. "Improvements in electrical accumulators." H. W. Cobb. February 25th.

4,005. "Improvements in or relating to electrical ship log apparatus." T. F. Walker and T. S. Walker. February 25th.

4,007. "Improvements in telephonic apparatus for central stations." C. D. Abel. (Siemens & Halske Aktien Gesellschaft, Germany.) February 25th. (Complete.)

4,017. "Improvements in the electrolytic bleaching of cotton and other textile materials, and in apparatus for use in connection therewith." A. A. Vogelsang. February 25th. (Complete.)

4,033. "Improvements in controlling apparatus for electric lifts." H. J. Haddan. (A. Stigler, Italy.) February 25th.

4,042. "Improvements in and connected with the production of electrotypes." S. Cowper-Coles. February 26th.

4,050. "Improvements in electrical switches." L. P. Perkins and H. Humphreys. February 26th.

4,088. "A safety device for overhead systems of street electric transmission of power." C. J. R. Le Mesurier. February 26th.

4,098. "Improvements in railway electric signalling apparatus." W. Hume. February 26th. (Complete.)

4,114. "Improvements in or applicable to the trolley system of electrical traction." S. H. Heywood. February 26th.

4,123. "Improvements in make-and-break switches or interrupters for electric circuits." G. E. Gaiffe and G. A. G. Contremoulins. February 26th.

4,128. "Improvements in and relating to slack-cable safety gears for electrically-operated lifts, elevators and the like." C. W. Hildred and H. C. Walker. February 26th.

4,215. "Improvements relating to electric switches." H. H. Lake. (The Telephonfabrik Aktiengesellschaft vorm J. Berlinger, Germany.) February 27th.

4,243. "Improvements in electrical circuit breaking, and making devices." J. W. Beauchamp. February 27th.

4,259. "The preparation, and use of calcium compounds for the electro-depositions of metals other than calcium." J. Kelly. February 28th.

4,290. "Improvements in mica insulation for electric apparatus." British Thomson-Houston Company, Limited. (C. F. Peterson, United States.) February 28th. (Complete.)

4,305. "An improved tidal motor for generating and transmitting electrical energy." R. W. Derbyshire. February 28th.

4,330. "Improvements in the connections or contacts of incandescent electric lamps for lighting and heating." H. J. Dowsing. February 28th.

4,337. "A new or improved stopping place indicator for electric cars and electric railways." J. B. McKenzie. March 1st.

4,366. "Improvements in safety devices for the trolley poles of electric cars." C. R. Bellamy, W. J. Turner, and D. R. W. Hardman. March 1st.

4,382. "An improved method of breaking the electric circuit in the overhead wires of electric tramways, railways, and the like, and apparatus therefor." C. C. Hewett. March 1st.

4,383. "Improvements in devices for producing by the electric volatilisation of metal wires, flashes for use in photography." J. Courtier. March 1st. (Complete.)

4,401. "An electric heater for liquids." T. K. Bellis. March 1st.

4,421. "Improvements in electric primary batteries." C. A. Hussey and S. G. Clarke. March 1st. (Complete.)

4,429. "Improvements in or relating to electric storage batteries or accumulators." F. M. Chaplet. March 1st.

4,487. "An improved magnetic brake for motors for electric lifts and other purposes." J. Bush and M. T. Medway. March 2nd.

4,489. "Improvements in electrolytic cells and in electrodes therefor." A. A. Vogelsang. March 2nd. (Complete.)

4,491. "Improved electrical remedial appliance." F. B. Lacy. March 2nd.

4,494. "Improved process for making electrodes for accumulators." W. P. Thompson. (Akkumulatoren und Electricitäts Werke Aktien Gesellschaft, formerly W. A. Boese & Co., Germany.) March 2nd. (Complete)

4,501. "Improvements in electric switches." G. W. Coxson. March 2nd.

4,508. "Improvements in accumulator plates." H. J. H. Pickard and J. S. Evans. March 2nd. (Complete.)

4,509. "Improved composition of paste for filling the cells of reticulated accumulator plates." H. J. H. Pickard and J. S. Evans. March 2nd. (Complete.)

4,519. "Improved construction of rail for electric and other railways or tramways." C. F. Hengst. March 2nd.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

7,479. "Improvements in secondary batteries." P. M. Justice. (The Proise Electric Storage Syndicate, Limited.) Dated April 10th, 1899. The positive plates are preferably made of lead, and covered with woollen or other absorbent material, and are formed in the usual way, the woollen covering serving to absorb a quantity of the electrolyte. One or more such plates are taken from the charging-cell, and used in combination with a single negative conductor or plate which is in the form of a casing of zinc adapted to contain the positive plates. 3 claims.

7,761. "Improvements in or relating to telegraphic transmitting instruments." J. Gardner. Dated April 18th, 1899. Transmitters for actuating Hertzian radiation apparatus are arranged either for signalling by the Morse code or for sending continuously or at intervals a repetition of some word or sentence. In this way the apparatus is applicable to signalling to vessels, and the hand-actuated Morse key may be omitted. In the apparatus the key actuates a bell-crank contact lever. The key lever has a tooth engaging with a signal transmitting wheel which is mounted on an axis in a rocking frame. The main shaft is driven by some form of motor, and is provided with a clutch thrown in and out of gear by worm and cam mechanism. The wheel is detachably mounted, and may be built up with separate teeth to suit the required signal. 5 claims.

7,776. "Improved method of adapting candelabra for the electric light." B. M. Drake and J. M. Gorham. Dated April 18th, 1899. Supporting lamps. Candelabra and candlesticks are adapted to carry electric lamps by providing one candle holder with a coupling to receive a plug supporting a lampholder, and from this flexible conductors are carried to the other lamp holders, either in series or in parallel, over the tops of the imitation candles, and are hidden by the shades used thereon. The holders fit loosely on their supports, so that all the holders and conductors are readily removable. 2 claims.

7,800. "Improvements relating to fusible electric cut-outs." H. G. Calthrop. (C. E. Peebles.) Dated April 18th, 1899. Cut-outs particulary adapted for use with or near lamps. A fuse forming part of or connected to a lampholder is constructed of an insulating block and is recessed and adapted to receive a covering block through a groove in which the fuse wire passes to terminals. The leads pass through holes and are also secured by a cord grip. At the lower end of the block is a neck for holding the lampholder, or the block may be directly connected to the holder. The block may have two or more recesses and carry a corresponding number of fuse wires, and may be fitted in electroliers, &c. 3 claims.

7,892 "Improvements in electrical batteries." E. W. Jungner. Dated April 14th, 1899. Relates to both primary and secondary batteries, and consists in the use of an electrolyte which remains unchanged during the charging and discharging of the battery, except that its solvent water is separated from it. Potassium and sodium hydrates are examples of such electrolytes. The plates or electrodes consist of insoluble oxides of metals or finely-divided metals, *e.g.*, one electrode may consist of silver peroxide pressed into a net of nickel wire, to which it is made to adhere by any suitable binding material, while at the same time its porosity is preserved. The other electrode consists of finely divided copper pressed into a copper wire net as in the other electrode. If there is used for the active mass of one of the electrodes a metal, such as iron, of which the oxide forms a hydrate stable in an alkaline solution, the other electrode must be provided with an equivalent quantity of a similar hydrate, such as hydrate of manganese, in order that, when the current passes, the hydroxyl molecule set free from one hydrate shall combine with the other hydrate. 2 claims.

7,916. "Improvements in the manufacture or production of bands and strips of copper and other metals by electrolysis on rotary mandrels." W. E. Heys. (E. Dumoulin.) Dated April 15th, 1899. Making metal bars. Relates to the manufacture or production of bands and strips of copper and other metals by electrolysis on rotary mandrels, and to improvements in the devices described in Specifications No. 16,360, A.D. 1895, and No. 2,709, A.D. 1897, in which the metals are deposited with the aid of "impregnators." This invention consists in forming helical grooves on the mandrels, and in filling the grooves with a suitable insulating substance, whereby the metal, after it is deposited, may be drawn off as a long strip very nearly rectangular or almost square in cross-section. 1 claim.

8,052. "Improvements in means for controlling electric circuits which will allow a circuit to be broken and completed from another circuit." H. Edmunds. Dated April 17th, 1899. Switches adapted for lighting incandescent lamps when arc lamps are extinguished, or for completing or opening one circuit by means of a current passing through another circuit. In the switch is arranged a magnet engaging with a material, such as nickel, the magnetic permeability of which is affected by heat. In one form an iron ring has a pair of poles wound with coils. The armature is pivoted, and to it is fixed a bent lever the end of which carries the bridging contact of the secondary lamp circuit. The other end engages under certain conditions with a pin carried by a lever. The lower end of this lever carries a permanent or other suitable magnet, and near it, in connection with the main arc lamp circuit, is the material, the magnetic properties of which are affected by heat. When the arc lamp circuit is closed, the armature moves and the lever is raised, the arm striking a projection on the lever forcing the magnet against the nickel piece, and bringing the catch beneath the end of the arm. After a certain time the nickel is heated and the magnet falls away. On then breaking the arc-lamp circuit, the armature turns under the weight of the arm and closes the secondary circuit. To break this circuit the main circuit is momentarily made and the magnet is permanently held against the nickel. Reference is made to specification No. 11,181, A.D. 1895 2 claims.

8,053. "A new or improved device for automatically effecting the breaking of an electric circuit after a predetermined time." H. Edmunds. Dated April 17th, 1899. Means for automatically breaking a circuit such as a lamp circuit after a predetermined time. A bar forming one part of a switch and also the armature of a magnet is made of material such as nickel, which loses its magnetic properties on heating. The bar is surrounded by a coil of suitable material, such as manganin or rheostene. On moving the arm to complete the lamp circuit it is held up by the magnet until it is heated by the current flowing through the coil. It then falls and breaks the circuit. The magnet may be an electro-magnet suitably connected with the circuit and the cut-out arm may be in shunt or any desired relation. 4 claims.

8,076. "Improvement to an electrical double-pole fused lamp-post (or bracket) water-tight switch to prevent fusing of main fuses." F. Carter. Dated April 18th, 1899. Switches and cut-outs for use in street lighting or other exposed places, being improvements upon the class of switch described in Specification No. 23,943, A.D. 1895. The spindle passing through the lid of the box is divided into two parts so that the lid and handle can be removed without disturbing the switch. The inner part of the spindle is slotted to engage with pins on the outer part, and carries a disc on which are fitted the contacts, which are adapted to engage with fixed contacts. On the disc is fitted a disc or collar of insulating material through holes in which pass the fuse wires. Arcing is thus prevented, and also accidental short-circuiting in removing the disc. 3 claims.

8,097. "Improvements in apparatus for regulating the arc in electric arc lamps." P. N. Chatterley. Dated April 18th, 1899. Arc lamps. An upper carbon holder is attached to a crooked tube through which passes a metal band or chain connecting the movable armature of a series solenoid or electro-magnet with a dashpot movable on a fixed piston. When current is supplied, the solenoid or magnet raises the armature and the tightened chain grips and lifts the tube, with the upper holder, thus striking an arc; as the carbons consume, these parts descend until the dashpot rests on the plate of the frame, or an adjustable stop, slackening the chain so that the tube slips. A spring or weight may be used instead of the dashpot. The provisional specification mentions the use of any suitably curved surface in place of the tube. 2 claims.

8,156. "An improvement in electro-magnets." A. L. A. C. d'Arlincourt. Dated April 18th, 1899. In order to permit of a wider range of movement, the armature of an electromagnet is divided into several members by planes parallel to the lines of force, these members being disposed at successively increasing distances from the magnet cores. When the nearest member is attracted, the others are carried towards the poles by means of abutments and are brought successively within the range of attraction. The magnet cores may each be made in one piece or divided into as many elements as there are elements in the armature. 2 claims.

8,188. "Improvements in rheostats or electric resistance switches." J. Marr and The Sunderland Forge and Engineering Company, Limited. Dated April 19th, 1899. Switches for starting, &c, motors. The contact arm of the resistance switch is held by an electro-magnet in gear with the operating handle as long as a current flows, but on a cessation of current one arm is released and returned to the position of maximum resistance. The contact arm is fixed to or forms part of a spindle on which is secured a worm-wheel. The worm is carried by links connected to a rocking shaft and is operated from the handwheel through a universal joint or other suitable mechanism. To the shaft is secured the armature of an electro-magnet which is energised when the circuit is completed at the main switch. The movement of the armature rocks the shaft throwing the worm into gear with the wheel. The spring serves to return the arm to the normal position, or it may be replaced by a weight or the like. 4 claims.

8,223. "Improvements in apparatus for testing electric primers, batteries and cells." G. C. Fraser. Dated April 19th, 1899. Testing.—A portable apparatus for measuring the currents necessary to five primers, and given by firing batteries, and for testing the condition of primers, consists of a dead-beat ammeter, connected in series with a key and a variable resistance, between two terminals in a case; two other terminals, connected together, are also provided. The ammeter scale may be provided with special marks in addition to an ampere scale. The variable resistance may extend up to 50 ohms, consisting partly of a resistant wire, coiled on a circular support to directly touch the contact arm, the higher resistances being coils connected between studs. A spring may be provided to return the contact arm automatically and place the maximum resistance in circuit. 2 claims.

8,240. "Improvements in safety devices for use in connection with electrical distributing systems." C. W. Partridge and The London Electric Supply Corporation, Limited. Dated April 19th, 1899. Device for protecting high potential circuits in case of a sudden rise in potential. Two relatively movable pole-pieces are connected through a resistance to the conductors, and an electro-magnetic arrangement is provided for separating them should an arc form. In the construction, one pole-piece is fixed and the other is carried on one end of the pivoted lever. The other end of the lever is connected to the core of the electromagnet, which is energised when arcing takes place. A horn is grooved or recessed for the movement of the lever, and assists in lengthening and so breaking the arc. In the form the pole is normally in contact with the horn, and sparking first takes place between the knobs enclosed within a suitable casing. 5 claims.

8,312. "Improvements in resistance coils." Cowans, Limited, and E. W. Cowan and A. Still. Dated April 20th, 1899 Resistance coils applicable for use in motor starting switches, resistant wire covered with cotton, or other carbonizable material, is wound on a support, enclosed by plaster of Paris or other heat resisting material to exclude air, excepting a small opening, and heated electrically or otherwise to carbonise the covering, after which it is finally enclosed. The support is constructed as shown in section. Four metal discs with bosses are connected by a central bolt, with intervening layers of mica, asbestos, or enamel, and fireclay sleeves. Ends of wires are clamped between the outer discs and two washers of the inner discs, the other ends of the wires are connected together and covered with the enclosing material. The outer discs are provided with connecting-bolts. 2 claims.

8,340. "Improvements in electric welding or metal working apparatus." A. F. Berry and R. J. Wallis-Jones. Dated April 20th, 1899. An electric welding-apparatus has clamps or other known devices for holding the plates to be welded, the current being supplied from a transformer of the kind described in specifications Nos. 2,801 and 9,457, A.D. 1897. In the form shown, the secondary coils consist of copper strips wound round the primary coil and connected in parallel to the blocks. The core consists of laminated plates arranged round the coils. Cooling-pipes may be arranged in the spaces. The strips or coils may be made in the form of a grid. The clamp is moved towards the clamp by a bell-crank lever and spring. When the plates have been sufficiently upset, the movement of the bell-crank lever operates a trip device to allow the circuit to be broken by a switch with a spring-actuated arm. The switch, which is of known construction, is reset by hand. 3 claims.

8,605. "An improved portable electric rivetting machine." F. S. Dudgeon. (F. von Kodolitsch.) Dated April 25th, 1899. A portable electric rivetter, which can be suspended from a crane, &c., has a fixed jaw and a movable jaw. The lower tool is pivoted, and is caused to move vertically by a drag link as the jaws are closed by toggle-levers. The levers are pivoted to a nut travelling on a sleeve driven by an electro-motor. The sleeve is mounted on a spindle pivoted to the frame, and carrying a fixed armature and commutator. Field magnets are mounted in a casing, which revolves on the spindle, and is held laterally by a thrust bearing. The motor circuit is completed through rings by rubbing contact. The screwed sleeve is driven when desired by completing the circuit of an electro-magnetic clutch through rings. The clutch consists of a coil in the end of the casing, and an armature carried by a spring disc on the sleeve. When the jaws have closed to the desired amount, the clutch circuit is broken, and the reaction of the jaws, &c., reverses the rotation of the sleeve and opens the jaws sufficiently to allow them to be placed over another rivet. The circuit may be broken automatically by a rod carrying an adjustable contact which makes or breaks circuit with a fixed contact. The contacts are placed in the clutch circuit, and the rod is mounted on the movable jaw. The outer ends of the sleeve and spindle carry discs between which friction rollers are placed. 5 claims.